To Ask or Not To Ask? Bank Capital Requirements and Loan Collateralization*

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Abstract

We exploit the 2011 EBA Capital Exercise, a quasi-natural experiment that required a number of banks to increase their regulatory capital but not others. This experiment makes secured lending for the affected banks more attractive *vis-à-vis* unsecured lending as secured loans require less regulatory capital. Using loan-level data

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covering the universe of bank loans in Portugal, we identify how banks require collateral on new loans when faced with higher capital requirements: relative to the control group, treated banks require loans to be collateralized more often after the shock. We find that the affected banks partially shield their relationship borrowers. The increased collateralization also has economically relevant real effects. Treated banks reallocate funds towards sectors with greater asset tangibility. Firms and sectors borrowing to a greater degree from treated banks exhibit lower growth and tilt their investments towards tangible assets.

JEL Codes: G21, G28, G32

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1 Introduction

Following the Global Financial Crisis, the regulation and supervision of the financial system has been drastically revised. Banks are now subject to tighter regulations (Basel III). A key feature of Basel III is higher capital requirements. Banks can fulfill these stricter requirements in several ways. Next to increasing regulatory capital, banks can shrink their risk-weighted assets (RWA) by deleveraging (i.e., reducing assets) (e.g., Hanson, Kashyap, and Stein, 2011; Gropp, Mosk, Ongena, and Wix, 2019). Banks may also save on regulatory capital by requiring loans to be collateralized as such loans carry lower risk weights.

In this paper, we document that banks require collateral more often on newly issued loans to decrease their risk-weighted assets when faced with tighter capital requirements: banks modify their lending technology and turn more to collateralized lending, in particular for their transactional borrowers. We show that this increase in collateralization is economically relevant as it contributes around 45% in the achieved reduction of RWA related to new corporate loans. Put differently, the effect of greater collateralization is about 80% of the deleveraging channel for newly issued corporate loans. We provide evidence that the increased collateralization of higher capital requirements generates real effects. Treated banks reallocate credit to sectors with high asset tangibility. Sectors and firms with more intangible assets borrowing from treated banks tilt their investments towards tangible assets, and show lower turnover and asset growth.

For identification we exploit a regulatory increase in bank capital requirements and study

the outcome of that increase on banks' granting of collateralized and uncollateralized loans. Requiring collateral is common in credit markets, especially in situations where lenders face severe asymmetric information.¹ A second way in which lenders mitigate asymmetric information is by screening borrowers, i.e., by acquiring information about their abilities and their project qualities. Increased capital requirements represent a shock to banks' choice of lending technology. To see this, consider an internal equilibrium before the shock, where the banks use a mix of the two technologies - information and collateral - with positive weights on each. This equilibrium trades off costs and benefits of the two technologies.² Then, increased capital requirements provide an additional benefit to the collateral technology. This is because collateralized loans require less regulatory capital, and so are financed with less equity and more debt: as long as debt is cheaper than equity, the regulatory minimum is cheaper to maintain with secured loans.³ Therefore, new loans, if any, are more likely to be collateralized.

Empirically, it is challenging to identify the effect of increased capital requirements on banks' lending behavior. Changes in capital requirements may be rare, endogenous to overall economic conditions, and applied to all banks at the same time. To overcome these concerns,

¹For theories on the usage of collateral in asymmetric information environments, see, e.g., Bester, 1985; Besanko and Thakor, 1987; Boot and Thakor, 1994; Inderst and Mueller, 2007; Karapetyan and Stacescu, 2018.

²While overcoming adverse selection is a common benefit for both technologies, they have different costs. In particular, collateral technology, that requires both interest payments and collateral from borrowers, will be costly for the bank as more collateral carries more liquidation loss while interest payments do not. In case of information acquisition, on the other hand, costs arise from exerting screening technology (see for instance Manove, Padilla, and Pagano, 2001).

³Appendix C, on risk weights, provides the institutional details lending credence to this claim. An example then illustrates how collateral based lending becomes relatively cheaper.

we use a loan-level data set covering all loans granted by banks to firms in Portugal, and employ the European Banking Authority’s (EBA) Capital Exercise as our key identification strategy (see Haselmann, Kick, Singla, and Vig, 2018; Gropp, Mosk, Ongena, and Wix, 2019, who exploit the same quasi-natural experiment to study other questions).

In October 2011, the EBA unexpectedly announced that a subset of European banks (including Portuguese ones) had to meet substantially higher capital ratios by June 2012. First, banks were required to hold a new, additional capital buffer against their holdings of sovereign bonds. Second, banks were instructed to increase their core tier 1 capital ratios to at least 9 percent of their risk-weighted assets. The new capital requirements, increased the relative cost of uncollateralized lending compared to collateralized lending for the affected banks but not for unaffected ones, allowing us to answer our research question in a difference-in-differences setting. The first hypothesis we test is: *affected banks will increase collateral requirements after the shock compared to control banks.*

Over time banks accumulate more accurate information about the borrower population, and informational screening becomes less costly compared to collateral.⁴ Because of this, the benefits from using collateral *may not necessarily be high enough to justify the switch for relationships borrowers*, with low screening costs. Therefore, the effect may be less pronounced for relationship borrowers. We thus extend our first question and ask: as capital regula-

⁴A number of studies document a decline in collateral requirements as the lending relationship progresses (Berger and Udell, 1995; Chakraborty and Hu, 2006; Jiménez, Salas, and Saurina, 2006; Bharath, Dahiya, Saunders, and Srinivasan, 2011). We also refer the reader to Boot (2000) for a review on the role of relationship banking in resolving problems of asymmetric information, and Liberti and Petersen (2019) on soft information in lending.

tion favors collateralized lending, do lending relationships mitigate the increased collateral constraints?

We further extend our analysis and investigate whether the collateral effect of capital requirements has any effects on the real economy. Sectors with mostly intangible assets that borrow heavily from treated banks may receive less loans and therefore grow less. Similarly, firms borrowing from treated banks might tilt their investments away from intangible assets and grow less.

Our main findings are as follows. First, treated banks are more likely to ask for collateral (relative to control banks) from the same firm in the aftermath of the EBA Capital Exercise. Second, this increase in collateral is less pronounced for relationship borrowers. The observed effect is economically large: while treated banks increase collateral requirements conditional on loans granted by about 6 to 10 percent, they do so to a lesser extent for relationship borrowers. In particular, in our triple-difference specifications we show that a borrower with a one standard deviation higher relationship length with her treated lender sees this increase to be smaller by 20 to 40 percent compared to a transactional borrower borrowing from the same bank. Third, we find that the collateralization effect is not transient but persists after the June 2012 implementation deadline as the higher capital requirements remained in place after this deadline.

Fourth, we further identify a collateral composition effect. In particular, treated banks are more likely to ask for *collateral leading to exposures with lower risk-weights* from the same

firm (relative to the control banks) but again partially shield their relationship borrowers from this increase. Fifth, we document real effects at the sectoral level as well as the firm level. We show that the sectors of the economy with more intangible assets that depend more on treated banks experience lower lending growth, asset growth, and employment growth. Firms receiving new loans from treated banks invest more in tangible assets, and exhibit a slower asset growth than similar firms borrowing from control banks. We further show that firms receiving new loans from treated banks also exhibit lower turnover, inventory and employment growth than similar firms borrowing from control banks, i.e., firm outcomes that are less subject to possible asset revaluations or reclassifications by firms and their lenders.

We conduct an array of robustness exercises to ensure the validity of our results. Some of the more important ones are as follows. The EBA Capital Exercise included the largest banks in terms of their market shares by total assets in each member state. Therefore, affected and unaffected banks differ in size in any given country. To overcome this size difference and understand the direction of a possible bias, we construct a matched control group containing only the largest non-treated Portuguese banks. We find that the effects become only slightly attenuated as larger banks might lend to larger borrowers with longer lending relationships, and therefore in comparison the treatment effects are somewhat less outspoken. We also exploit the *intensity of treatment* as not all banks were required to increase their capital requirements to the same degree. We find that more intensively treated banks are more likely to ask for collateral, but again partially shield their relationship borrowers. Finally,

a potential concern could be that Portugal has been subject to other events such as the sovereign debt crisis and bank bailouts. We mitigate the impact of these possible confounding factors by also employing short windows around the EBA Capital Exercise and providing falsification tests.

Our paper contributes to the literature on relationship banking and collateral pledging in normal and stress periods.⁵ There is an extant empirical literature on how *ex ante* information asymmetries and observed risk impact the incidence of pledging collateral (e.g., Berger, Frame, and Ioannidou 2011; Berger, Espinosa-Vega, Frame, and Miller, 2011 and references therein). More recent studies have focused on the global financial crisis and the role of bank-level characteristics in overcoming frictions (e.g., Chodorow-Reich, 2014; Iyer, Peydró, da-Rocha-Lopes, and Schoar, 2014; Ongena, Peydró, and van Horen, 2015; Bolton, Freixas, Gambacorta, and Mistrulli, 2016; Cingano, Manaresi, and Sette, 2016; Banerjee, Gambacorta, and Sette, 2017; Beck, Degryse, De Haas, and van Horen, 2018). Rather than focusing on access to funding and types of banks, we focus on access to *unsecured* funding, and how relationships affect such access using a shock to banks' capital requirements. Bolton, Freixas, Gambacorta, and Mistrulli (2016) develop and empirically test a model in which relationship banks gather costly information about their borrowers, which allows them to provide more informed loans to profitable firms during a crisis.

Closer to our work, several papers have studied the impact of regulatory policies on

⁵For a review, see Boot, 2000; Degryse, Kim, and Ongena, 2009; Kysucky and Norden, 2016, among others.

credit shifts from a high risk-weight sector to a low risk-weight one (labelled as 'de-risking' channel). Juelsrud and Wold (2020) show that lowly capitalized banks decrease supply of corporate credit more relative to collateralized housing credit. Bidder, Krainer, and Shapiro (2018) study the composition of banks' loan portfolios as a response to losses in bank net worth from oil price fluctuations. Banks shift from heavily risk-weighted assets to lower risk-weighted assets, from on-balance sheet to off-balance sheet assets. Firms are less impacted as they switch from heavily affected to less affected banks. Compared to those papers, our focus is on collateralization behavior in the corporate sector and the impact *within* the same firm. Furthermore, we study the real effects from this increased collateralization at sectoral and firm level.

Similar to our setting, Gropp, Mosk, Ongena, and Wix (2019) study the EBA Capital Exercise and show that banks reduce their credit supply (rather than raising new equity). Behn, Haselman, and Wachtel (2016) study how an external shock to credit risk affects lending to firms borrowing simultaneously from banks facing the increased model-based capital charges and those with fixed capital charges, and find that the former reduce credit supply more to a given firm.⁶ Consistent with these, but making use of more granular data, we also find that treated banks reduce credit supply to their borrowers but partially shield their relationship borrowers. We then contribute by analyzing the collateral requirements of a new credit at the loan level *conditional on a new loan being granted*. Thus, the aim of

⁶A number of other studies have analyzed the credit supply implications of increased capital requirements or increased cost of equity. See Aiyar, Calomiris, Hooley, Korniyenko, and Wieladek, 2014; Célérier, Kick, and Ongena, 2018; Fraisse, Lé, and Thesmar, 2020, among others.

our study is to see whether apart from decreasing credit, or shifting between sectors, banks use increased collateralization to meet new capital requirements. Importantly, we estimate that for new corporate loans granted by treated banks, the magnitude of this mechanism in reducing total risk weighted assets to be around 80 percent of the credit supply channel. To the best of our knowledge this way of optimizing risk-weighted assets regarding new corporate loans to achieve regulatory capital requirements has not been documented previously.

2 The EBA Capital Exercise

2.1 The Event

On October 26, 2011, the European Banking Authority (EBA) announced a Capital Exercise which required a subset of European banks to hold additional buffers against sovereign exposures and reach a 9% core tier 1 (CT1) capital ratio by June 2012. The exercise was undertaken with the aim of building confidence in the ability of euro-area banks to withstand adverse shocks (and still have enough capital), including in part those arising from the exposure to sovereigns. This regulatory action is arguably suitable as a quasi-natural experiment. First, it was largely unanticipated by economic agents (Mésonnier and Monks, 2015; Gropp, Mosk, Ongena, and Wix, 2019). The EBA had just conducted stress tests in July 2011, and had already released detailed information on the exposure of European banks to sovereign risk. Gropp, Mosk, Ongena, and Wix (2019) argue that the credibility of the June stress

tests could be questioned. Only nine out of the sixteen groups which narrowly passed the test were finally included in the Capital Exercise. In addition, the level of the new required core tier 1 capital ratio was substantially higher than the one planned under the transition to Basel III, and was not explicitly related to the level of risks of any particular banking group. Second, it targeted banks in descending order of their market shares in each Member State such that it affected only the largest banks in each Member State. This generated a well-defined counterfactual.

As a result, it is fair to assume that the increased capital requirements came as a surprise for most of the banking groups involved in the Capital Exercise. In December 2011, the EBA issued a press release identifying twenty seven banks as having an aggregate capital shortfall of 76 billion euros. These banks were required to submit capital plans to the EBA through their national supervisory authorities by January 2012 and an evaluation of the plans was to be done by February 2012.

The EBA Capital Exercise was applied in each EU member state, using a country-specific selection rule. It included the largest banks in terms of their market shares by total assets in each country. In descending order of size, the marginal affected bank would be such that at least 50 percent of the national banking sector in the respective country would be covered. Therefore affected and unaffected banks will eventually differ in size.⁷

In the Portuguese context, owing to the presence of many small firms, the banking

⁷We address this issue later in the empirical section. However, we find little difference across the two groups, with respect to other observable bank characteristics, like liquidity and solvency ratios, sovereign exposures, profitability, and loans and deposits as a fraction of total assets.

system is one of the most important sources of credit for businesses. Fewer than one percent of Portuguese firms have access to capital markets. The domestic credit to the private sector as a percentage of GDP peaked at about 160 percent in 2009.⁸ There are about 180 credit granting institutions in Portugal which can be grouped into 33 banking groups. The largest 8 banking groups account for about 82 percent of the total banking assets and around 82 percent of loans with only marginal variations from year to year. Four out of the eight biggest banking groups were involved in the Capital Exercise and were required to increase their capital ratios. The total capital shortfall (after including the sovereign capital buffer) for all banks operating in Portugal stood at 6,950 million euros which is roughly 6 percent of the aggregate shortfall in the euro-area. This amount of shortfall was approximately equal to 22 percent of total capital or 30 percent of core tier1 capital (as of 2011:Q2) of affected banks. Gropp, Mosk, Ongena, and Wix (2019) argue that exposed banks aimed to comply with the higher capital ratios without raising costly new capital.⁹

2.2 Hypotheses

We formulate several hypotheses related to the EBA Capital Exercise. Our first hypothesis relates to the impact of the EBA Capital Exercise on the granting of collateralized loans at treated and control banks. We formulate our hypothesis based on the impact the quasi-natural experiment had on banks' relative cost of extending collateralized versus unsecured

⁸Source: World bank data.

⁹Refer: (<http://www.eba.europa.eu/risk-analysis-and-data/eu-capital-exercise>) and related documents listed therein for further details.

loans. Collateralized loans have lower risk weights. In our context, this means that bank-firm exposures secured by collateral require less regulatory capital than unsecured exposures. This makes extending collateralized loans cheaper relative to screening-based loans as long as equity is costlier for the banks than debt. This will, therefore, increase treated banks' incentives to require collateral on new loans.¹⁰

Will the affected banks then (at least partially) meet the increased capital requirements by modifying their lending technology and giving preference to secured lending after the implementation of the exercise? We expect this to be the case, since the increased regulatory capital requirement gives an additional benefit to the collateral technology: as collateralized loans require less (or no) regulatory capital, a new secured loan will be financed by cheaper debt. Unsecured loans, by contrast, will be costlier to finance by capital, while maintaining the newly imposed regulatory minimum. The additional benefit should be reflected in the granting of collateralized loans rather than uncollateralized ones for the banks that were required to increase capital ratios - the *treated banks*, (denoted by *Treated*).

Furthermore, over time banks reduce screening costs per relationship borrower since by accumulating information they avoid costs from unnecessary screening of already revealed uncreditworthy borrowers with too many defaults: screening is only done for a better quality

¹⁰Under the Standardized Approach (the system used by the majority of Portuguese banks) secured exposures receive a preferential risk weight. For instance, exposures secured by governmental guarantees or by financial institutions will have zero risk weight. Exposures secured by immovable property, such as residential real estate and commercial immovable property, benefit from preferential risk-weights (see Directive 2006/48/EC (the original CRD)). In the Internal Ratings-based Approach a lower probability of default and loss-given default can be assigned to collateralized loans. We provide further details of the impact of collateralization on risk-weights in Appendix C.

pool of repeat applicants, who have higher (updated) probabilities of a successful project.¹¹ Because of this, the benefits from using collateral *may not necessarily be high enough to justify the switch for relationships borrowers* with low screening costs. Therefore, while banks may switch to secured lending after the regulation for transaction borrowers, the effect will be less pronounced for relationship borrowers. We thus extend our first question and hypothesize that the increase in collateral requirements, after the Capital Exercise, will take place by treated banks, but only to a muted extent for relationship borrowers. Accounting for this key heterogeneity completes the formulation of our first hypothesis.

H1: *Following the EBA Capital Exercise, the loans granted by treated banks are more likely to be collateralized than those by control banks. This effect will be muted for relationship borrowers.*

To incorporate the role of relationships, we employ two measures of relationship strength; elapsed *relationship length* from first interaction (in natural logarithm of months) and the number of loan interactions with a bank up to the point of the new loan origination (*Cum. Relationship* (in natural logs)). In the specifications, our focus is on the differential effect of the EBA exercise for the use of collateral for *relationship versus transactional* borrowers.

Our second hypothesis focuses on the set of collateralized loans and investigates hetero-

¹¹At the same time, *ceteris paribus*, the expected cost of using collateral remains constant over time, because the probability of success of a bad project is fixed (and so is the amount of collateral necessary to violate the participation constraint) in a given economy, and is independent of the history of borrower population (Manove, Padilla, and Pagano, 2001). Precisely, the collateral liquidation cost is only a function of the success probability of the bad project, since the bank asks just enough collateral to break the participation constraint for the bad project, i.e. $P_B * R + (1 - P_B)C \leq 0$, P_B is the success probability of the bad project, while C, R stand for collateral and interest rate; Bester (1985).

generality within the collateral pledged. In particular, some types of collateral induce loans to carry lower risk weights than other types. For example, real estate and guarantees provided by financial institutions or governments carry much lower risk weights than accounts receivables, inventory or guarantees by individuals and firms. We therefore hypothesize that treated banks are more likely to grant loans with collateral that entail lower risk weights, after the shock, than the control banks. In line with our previous hypothesis, we also test that this effect is prevalent but muted for relationship borrowers. Our second hypothesis (H2) can be formally stated as:

H2: *Following the EBA Capital Exercise, collateralized loans granted by treated banks are more likely to have ‘low-risk-weight collateral’ than those by control banks. We expect this impact to be muted for relationship borrowers.*

Recent work has shown that reduced lending matters for firm-level real outcomes, such as employee or asset growth (e.g., Chodorow-Reich, 2014; Buera and Karmakar, 2019; Gropp, Mosk, Ongena and Wix, 2019). Since lack of collateral is known to be a key reason for failing to obtain credit, the switch to the collateral technology stemming from the higher capital requirements may then cause real effects via reduced credit to sectors without collateral, or may shift firms’ investment decisions towards more tangible projects. We formulate a third hypotheses regarding the effects of the Capital Exercise on real variables. We first ask: do increased collateral requirements cause credit reallocation from sectors with few pledgeable assets to those with large enough pledgeable assets. This finding would then suggest that in-

creased collateral requirements would unfavorably affect banks' decisions making them forgo their initial, unconstrained choices. Second, are increased collateral requirements important for firm level outcomes, even when they have access to credit? Banks requiring higher collateral may have an impact on firms' investment decisions as they may tilt their investments towards fixed or tangible assets. This is summarized in the third hypothesis:

H3,A: *Increased collateral requirements cause credit reallocation from sectors with few pledgeable assets to those with more pledgeable assets.*

H3,B: *Increased collateral requirements tilt a firm's investments towards fixed or tangible assets, and induce negative real effects.*

We provide the empirical specifications to test our hypotheses and results in sections 4 and 6.

3 The Data

Our data come from three sources. First, we use the central credit register (CRC) of the Bank of Portugal. The CRC contains information, reported by all credit granting institutions, on all loans granted to firms. Any loan above 50 euros is recorded in the CRC, implying full coverage. Our sample covers the entire population over the window first quarter 2011 to second quarter 2012. For some variables, we rely upon information from the CRC starting from January 2005. The database includes information on borrower and lender unique identifiers, amount of outstanding loans at end of each month, and the status of outstanding

credit (good, overdue etc.). In most of our exercises, we focus on borrowers who have at least two banking relationships, and on one type of credit: lines of credit. In the robustness section, we conduct additional exercises.

Banks also report information on collateral to the CRC.¹² We use this information to construct our dependent variable (presence of collateral) for all newly generated loans during our event window (more details below) around October 2011. We define a new loan being granted (*New loan = 1*) by a given bank to a given firm in any month if we see either a new bank-firm relationship, or an increase in the number of loans in a bank-firm pair.

We construct two variables to measure a firm's relationship status. We take advantage of the longer time span of the CRC to build bank-firm relationship variables, based on borrowing history, starting from January 2005: this means that for a bank-firm interaction during our sample period in, for instance, 2011, the relationship length is measured using all relationship history from 2005. Our first main independent variable is the elapsed time (number of months) since the first interaction between a firm and a bank, the *relationship length*. In our empirical specifications, we use the natural log of relationship length in months.

The second measure is *cumulative relationship* (or *cum. relationship*) - the relationship strength as proxied by the *frequency of interactions* up to the point of origination of the loan under consideration. Unlike relationship length which measures the time elapsed from

¹²We have information about the type of collateral and the amount pledged at issuance (if a single loan is backed up by several sources of collateral, their respective types and amounts are reported. It must however, be noted that the collateral value is not marked to market, and is often truncated to be equal to the loan if the value of collateral exceeds the loan amount. Therefore, for our analysis, we will only use the information if a loan is collateralized or not and not the actual value of collateral.

first interaction until the current period, the cumulative relationship measure captures the *active* time between the parties until the current period. The measure is constructed by counting the number of times a new loan has been granted, since the first interaction. Thus, at any given point in time, the measure shows the cumulative number of interactions since the start. This *active* length may better capture the depth of the information acquired by the bank. As in the *relationship length* measure, this variable is also computed starting in January 2005.

We then combine the CRC database with bank and firm information. Firm characteristics such as size, age, profitability and industry are taken from the Central Balance Sheet Database (CBSD), and are available at an annual basis. This database covers mandatory financial statements reported in fulfillment of firms' statutory obligations under the Informacao Empresarial Simplificada (Simplified Corporate Information, IES). Information on banks' balance sheet items (such as total assets and capital and liquidity ratios) is taken from the Bank of Portugal's Prudential Database (PD). These statistics are reported monthly.

The summary statistics are provided in Table 1. The descriptives about the dependent variables and the relationship variables are for borrowers with at least two banking relationships, and hold for our event window running from January 2011 to June 2012. Our purpose is to track collateralization of new loans only. Accordingly, our main dependent variable - *Collateral dummy* - is constructed as follows. If a new loan is generated as above, we count the number of collateralized loans in the current as well as the previous month. Whenever

the number of collateralized loans has increased, we set the collateral dummy equal to 1 for that particular firm-bank pair in that month, and 0 otherwise. Table 1 shows that about 50 percent of all new loans is collateralized. Treated banks on average are more likely to ask for collateral than control banks.

Our second dependent variable *low risk weight collateral* shows that 24 percent of all collateralized loans have collateral inducing loans to carry low risk-weights. The table further shows that the mean *relationship length* and *cum. relationship* are 44 months and 17 interactions, respectively, with a high variation in the sample. Borrowers from treated banks have somewhat longer relationships and the same applies for firms borrower simultaneously from both treated and control banks.

Next, we provide summary statistics of our firm and bank specific variables. The firm-level variables are annual and reported for the end of 2010. The average firm has total assets of 2.4 million euros. Firms employ on average about 27 employees. These figures show that Portuguese non-financial firms are mainly small and medium sized firms which are quite bank dependent. In our empirical specifications we employ the natural logarithm of the number of employees (or total assets) as a proxy for firm size. We restrict our analysis to firms with at least 2 bank relationships. The firms in our sample have 2.58 bank relationships on average. As expected, the firms that patronize the larger (treated) banks are bigger in size. We address this both in our matching exercise as well as by saturating nearly all of our specifications with firm (and firm-time) fixed effects.

We report summary statistics of bank characteristics by bank status just before the EBA Capital Exercise in Table 2. In the table and the empirical sections that follow, we drop all non-Portuguese European banks that are affected by EBA Capital Exercise. We do so because the EBA Capital Exercise was conducted at the consolidated level, and so the effect of a foreign subsidiary may not be comparable to the one on the consolidated balance sheet of a Portuguese bank. In one of our robustness checks, we also report our results including those banks.

Table 2 reports total assets, liquidity ratio, and capital ratio for control and treated banks separately. Furthermore, the variables are also shown for the matched group, to illustrate reduction in the existing bias across the two groups. While the banks were comparable in their CT1 capital ratios, treated banks are much larger, and they needed an additional capital buffer to cover for risks associated with sovereign holdings, according to the EBA. The large size divergence is due to the implementation rule of the EBA Capital Exercise. The *matched control* group reduces the difference by about 40 percent. We describe the matching and use the matched control group for robustness in the empirical section. The bank liquidity ratio is the sum of cash and short term securities normalized by total assets. The bank capital ratio is the tier 1 core capital over risk-weighted assets. The mean is just below (above) 8 percent for treated (control) banks.

4 Results

We first discuss our findings related to hypothesis 1 and 2. In the third subsection, we discuss the impacts after the full implementation of the EBA Capital Exercise while subsection 4.4 studies bank level outcomes. All our main tables are in Appendix A.

4.1 Test of H1

4.1.1 Diff-in-Diff

We focus on the 2011:Q1 to 2012:Q2 period, where we use a set of difference-in-difference estimators to quantify the effect of the EBA Capital Exercise on treated banks' borrowers.¹³ (We refer to subsection 4.3 for the effect of the EBA Capital Exercise after its full implementation in June 2012.) We test the main hypothesis: treated banks are more likely to ask for collateral following the EBA Capital Exercise. We first show the simple difference-in-differences results for the first part of H1, ignoring the role of relationships. Formally, we test the following equation:

$$y_{i,j,k,t} = \alpha + \beta * Treated * Post + \delta x_{i,j,k,t} + \gamma * f_{i,t} + \eta * b_{j,t} + \lambda_j + \mu_t + \epsilon_{i,j,k,t} \quad (1)$$

¹³In Appendix D, we report results on the impact of the EBA shock on credit supply to relationship and transactional borrowers. Consistent with Gropp, Mosk, Ongena, and Wix (2019), we find that treated banks reduce credit supply but less so for relationship borrowers.

where $y_{i,j,k,t}$ is the collateral dummy of loan k granted by bank j to firm i in month t . $x_{i,j,k,t}$ denotes the log of the loan volume, $f_{i,t}$ and $b_{j,t}$ denote time-varying firm and bank characteristics (described in the notes to the table), while λ_j and μ_t denote bank and time fixed effects, respectively. We control for loan volume since larger loans are more likely to be collateralized. Depending upon the specification, we further include firm or firm*time fixed effects.

In Table 3, the pre-EBA period each time includes the first 6 months of 2011, i.e., Q1 and Q2 of 2011, i.e., the quarters preceding the EBA announcement. Column 1 shows results when considering only the immediate impact of the announcement in October: the post-event period is defined as the Q4 of 2011 and Q1 of 2012 (indicated by Q4,Q1 on top). The *Post * Treated* shows that for treated banks new loans are 5.1 percentage points more likely to be collateralized when compared to the pre-event period and control banks. This is equivalent to a 10 percent increase on the unconditional mean of collateralization in our dataset. Columns 2, 3, and 4 focus on the post period Q1 and Q2 2012 (indicated by Q1,Q2 on top), where June 2012 was the deadline for implementing the EBA Capital Exercise. Columns 2, 3 and 4 differ in terms of the fixed effects included. We observe that *Post * Treated* remains between 3 and 4 percentage points depending upon the fixed effects included. Notice that the identification comes from firms that take new loans from multiple banks, i.e., within the same firm or firm-time (columns 3 and 4, respectively).¹⁴

¹⁴While the inclusion of firm-time fixed effects is preferred to control for demand, it may imply that identification comes from different sets of firms before and after the Capital Exercise.

The fact that conditional on receiving a loan they are more likely to pledge collateral at EBA banks after the shock thus controls for possible firm financing frictions. Identification then mainly comes from firms that could pledge collateral (e.g., Nikolov, Schmid, and Steri, 2020). Finally, throughout our models we control for loan volume, since larger loans are more likely to be collateralized: the coefficients for log of volume hover around 0.14 to 0.15, which means that a loan which is 2.72 times as large is 14-15 percentage points more likely to be collateralized.

We further confirm our results by using an alternative dependent variable, defined as the ratio of collateralized loans over total loans between a firm and a bank in a given month. The purpose of this additional exercise is to corroborate our results by showing that the collateralization of a new loan does not stem (or does not stem entirely) from unwinding collateral from other existing loans between a firm and its bank, and to study whether banks do not modify their collateral requests on previously granted, outstanding loans. To answer this question, we compute the ‘collateralization ratio’, i.e., the ratio of collateralized loans over all loans between a firm and a bank, outstanding at time t :

$$z_{i,j,t} = \alpha + \beta * Treated * Post + \gamma * f_{i,t} + \eta * b_{j,t} + \lambda_j + \mu_t + \epsilon_{i,j,k,t} \quad (2)$$

where $z_{i,j,t}$ is the ratio of collateralized loans over all (existing and newly issued, if there is one) loans that prevail between bank j and firm i in month t . We also add additional controls as in the previous specification (described in detail in the notes to the tables).

In Table 4 columns 1 and 2 show results for firms that obtained a new loan during our sample period. We find that after the issuance of a new loan this ratio increased between 3.5 and 4.3 percentage points, depending on the specification. In columns 3 and 4 we use the sample of already originated loans, dropping all new loan observations, to see whether firms underwent any changes in collateral requirements on previously outstanding loans. Could it be that banks at the time increased collateral requirements for existing loans during renegotiation process (Papoutsis, 2019)? Or, in contrast, is it the case that increased collateral requirements for new loans can be obtained by unwinding collateral on existing loans? In the latter case, we should see a negative effect when constraining the sample to already outstanding loans. We do not find a statistically and economically relevant effect in column 3 and only a mild negative effect in column 4. Thus, there was only limited change in the collateralization rate for the existing stock of loans, and if anything results go in the opposite direction compared to new loans.

4.1.2 Role of Relationships

We now move to test the second part of H1, allowing for the fact that affected banks treat their relationship borrowers differently: they increase collateral requirements less for the relationship borrowers. To focus on the differential effect of the EBA exercise for the use of collateral for *relationship versus transactional* borrowers, we define the following triple interaction specification:

$$\begin{aligned}
y_{i,j,k,t} = & \alpha + \beta * relationship\ strength_{i,j,t} + \delta * relationship\ strength_{i,j,t} * Treated * Post + \\
& \delta_1 * relationship\ strength_{i,j,t} * Treated + \delta_2 * Treated * Post + \\
& \delta_3 * relationship\ strength_{i,j,t} * Post + \theta * x_{i,j,k,t} + \gamma * f_{i,t} + \eta * b_{j,t} + \lambda_j + \mu_t + \epsilon_{i,j,k,t}
\end{aligned} \tag{3}$$

where *relationship strength* is either *relationship length* or *cumulative relationship*. In some specifications we further include firm or firm*time fixed effects. Support for H1 would be reflected in a positive coefficient for *Treated * Post*, and a negative coefficient for *relationship strength_{i,j,t} * Treated * Post* in equation 3.

In Table 5, columns 1-4 (5-8) we show the results where we employ *relationship length* (*cum. relationship*) as our relationship strength indicator. We use pre- and post-EBA windows to quantify the diff-in-diff and triple-difference effects. The pre- and post-EBA Capital Exercise periods are defined as before. In columns 1 and 5 we use two quarters immediately following the *start of* the exercise as the *Post* period, i.e., Q4:2011 and Q1:2012. In the rest of the table, we allow for a 3-month adjustment after the start of the exercise, i.e., using Q1 and Q2 of 2012 as the *Post* period. According to the EBA announcement, the deadline to meet the new requirements was set at the 30th of June, 2012.

Table 5 shows that the coefficient on *Post * Treated* is positive and statistically significant in most specifications: treated banks increase collateral requirements conditional on loans granted (in short, collateral requirements) after the EBA Capital Exercise. The

triple interaction instead shows a statistically significant and negative coefficient in all specifications, consistent with H1. The results show qualitatively and quantitatively significant effects. In column 2, while affected banks increase collateral requirements by 3.4 percentage points ($Treated * Post = 0.034$), which is about 7 percent of unconditional mean, they do so less for relationship borrowers. To infer the impact of relationship length, we compare the impact of the Capital Exercise for a borrower with an average relationship length at a treated bank versus a transactional borrower (i.e., comparing a 64 months to zero month relationship length) relative to the conditions similar borrowers would have had before the treatment at the same bank. Based on column 2, while a transactional borrower sees collateral requirements increase by 3.4 percentage points, an average relationship length borrower sees collateral requirements increase by 2.7 percentage points.¹⁵

4.1.3 Intensity of Treatment

In our empirical analysis up to now, we assumed that all treated banks received the same treatment intensity. We now repeat our analysis by taking into consideration the magnitude of the treatment the banks were subject to. In particular, we consider the total *shortfalls* that the banks had to cover with respect to both the new CT1 level and the additional sovereign capital buffer. The numbers are public information and are taken directly from the EBA’s website. These shortfalls, as a percentage of risk-weighted assets are 2.34, 3.7,

¹⁵At the maximum relationship length in our sample (108 months), the increase would be 2.4 percentage points.

2.36 and 5.48 for the four affected Portuguese banks (all banks in the Capital Exercise had a shortfall). The results of our empirical model where we replace *Treated* by *Shortfall* are presented in Table 6. We find that the impact of the treatment, on collateral requirements, depends on the treatment intensity (i.e., shortfall). In column 2 for instance, in terms of the average effect at 3.5 percent shortfall, the double coefficient shows an increase of 2.45 percentage points ($3.5 \times 0.007 = 0.0245$) in collateralization for treated banks.

4.2 Test of H2

We now turn to our second hypothesis relating the EBA Capital Exercise to the type of collateral pledged. Capital regulation specifies that loans carry lower risk weights when they are secured with higher quality collateral. Our collateral data contains information on six types of collateral: real estate; financial collateral; guarantees by state or financial institution; movable assets (like machines, cars); other guarantees; personal guarantees by a firm or an individual. Regulation puts lower risk weights for the first three types of collateral (BCBS (2006)). We therefore create a dummy variable *low risk weight collateral* equal to one when the collateral type is real estate, financial collateral, or guarantees by state or financial institution, and zero otherwise (i.e., when the collateral type is movable assets, other guarantees, and personal guarantees by a firm or an individual).

Formally, within the set of collateralized loans, we test the following:

$$\begin{aligned}
z_{i,j,k,t} = & \alpha + \beta * relationship\ strength_{i,j,t} + \delta * relationship\ strength_{i,j,t} * Treated * Post + \\
& \delta_1 * relationship\ strength_{i,j,t} * Treated + \delta_2 * Treated * Post + \\
& \delta_3 * relationship\ strength_{i,j,t} * Post + \theta * x_{i,j,k,t} + \gamma * f_{i,t} + \eta * b_{j,t} + \lambda_j + \mu_t + \epsilon_{i,j,k,t}
\end{aligned} \tag{4}$$

where $z_{i,j,k,t}$ is a dummy for *low risk weight collateral* and is equal to 1 if the collateral securing loan k granted by bank j to firm i in month t induces the loan to carry a ‘low risk weight’, and zero otherwise. As before, $x_{i,j,k,t}$ denotes log of the loan volume, $f_{i,t}$ and $b_{j,t}$ denote time-varying firm and bank characteristics, while λ_j and μ_t denote bank and time fixed effects, respectively.

The results of estimating equation 4 using the *low risk weight collateral* dummy as dependent variable are presented in Table 7. The sample is now restricted to all new loans that are collateralized. The structure of the table is similar as before; columns 1 and 5 take Q4:2011 and Q1:2012 as the post period whereas the other columns employ the first two quarters of 2012 as post period (each time indicated on top of the column). The first four columns present the results for *relationship length*, and the last four columns for *cum. relationship*. The table shows that treated banks were around 19.5 to 34.5 percentage points more likely to ask for ‘low risk weight collateral’ compared to unaffected banks following the EBA Capital Exercise. However, this effect is muted by about 25 percent for borrowers with one standard deviation higher relationship measure. For instance, in column 1 the total

effect is $0.345 - 0.92 * 0.085 \approx 0.26$, and in column 5, it is $0.381 - 0.75 * 0.118 \approx 0.29$. This result supports H2 as the EBA Capital Exercise leads to a more intensive pledging of *low risk weight collateral*, but to a muted degree for relationship borrowers.¹⁶

Finally, we also investigate the impact of *treatment intensity* as measured by *Shortfall*. We expect that firms dealing with banks suffering a more intense treatment will be required to pledge *low risk weight collateral* rather than other collateral after the treatment. The results of our empirical model where we replace *Treated* by *Shortfall* are presented in Table F2 in Appendix F. Our main conclusions hold.

4.3 Impacts After Full Implementation of EBA Capital Exercise

In addition to the increased capital requirements, the EBA Capital Exercise required that banks also maintain their achieved higher capital levels after the full implementation of the EBA Capital Exercise of June 30, 2012. These higher levels were to be maintained until the recommendation were to be amended, repealed, or canceled.¹⁷ In terms of our analysis, the requirement to maintain implies that we should not observe further increases, or decreases in the rate of collateralization of loans issued by treated banks compared to their peers. In

¹⁶Since low-risk collateral includes government guarantees, we recognize that it is possible that the government or other financial institutions might have issued guarantees to further support potential borrowers in obtaining low risk weight collateral. This type of collateral does not constitute a significant share, and in appendix F we add Table F1 where we have excluded loans backed by such collateral from the sample. Our results remain largely unchanged. In unreported regressions, we also follow Mayordomo, Moreno, Ongena, and Rodriguez (2018) and group collateral into *real* versus *personal* collateral. We do not find any significance for the double and triple interaction terms in explaining this grouping of collateral. This suggests that risk-weights are the determining factor in our analysis.

¹⁷See documentation in EBA (REC 2011(1), page 5.)

Table 8 we test this by defining an indicator variable *Post* taking value 1 for loans created after June 30, 2012. The different columns in Table 8 use different pre and post periods (each time indicated on top of the column). Columns 1 and 2 investigate what happens after full implementation of the EBA Capital Exercise relative to the quarters during the adjustment phase. Since banks need to maintain their achieved capital levels, the null hypothesis is that the coefficient on the *Post * Treated* and *RelationshipLength * Post * Treated* are zero. Columns 1 and 2 consider Q1 and Q2 of 2012 as *Pre* and Q3 and Q4 of 2012 as *Post*. As expected, in columns 1 and 2, both the double and the triple coefficients of interest are statistically insignificant. The picture changes in columns 3 and 4, where we study the overall effects from before the EBA Capital Exercise (Q1 and Q2 of 2011) to the post-deadline period (Q3 and Q4 2012). These numbers are comparable to those in Table 5. For instance, in the specification that is saturated with firm-time fixed effects (column 4), the double coefficient shows a 3 percentage point increase. In sum, we find that the effects of the EBA Capital Exercise persistently modify treated banks' lending behavior.¹⁸

Finally, we repeat the exercise with type of collateral. Our goal is to confirm that banks neither increased nor decreased focus on low-risk weight collateral after the full implementation of the EBA Capital Exercise compared to the implementation period. Results are reported in Table 9. The pre and post periods are similar as Table 8. *Post * Treated* is statistically insignificant for columns 1 and 2, while it is significant with comparable overall

¹⁸However, we want to point out the caveat that some banks of the treated and control group received bailouts in Q3 and Q4 of 2012. Our results are robust to excluding these banks from the analysis.

effects in columns 3 and 4. For the triple coefficient, we see a statistically significant outcome in columns 1 and 2, however magnitudes are economically small: compared to the overall effect reported in columns 3 and 4, these are more than 11 times smaller. These results again suggest that the treated banks persistently modify their lending behavior.

4.4 Bank-level outcomes

In this subsection, we aim to answer three questions. First, did EBA banks grant loans to less risky firms than their non-EBA counterparts after the EBA Capital Exercise? If treated banks shift towards less risky borrowers, for example to avoid future capital pressures, then the EBA Capital Exercise may not only generate more secured loans but also generate firm composition effects which could be an additional benefit for financial stability. To see whether this channel is at work, we compare the riskiness of firms that received new lending before and after the treatment from EBA banks, relative to what happens at non-EBA banks. If this were true, we would expect firms' riskiness indicators at EBA banks to improve considerably, relative to non-EBA banks. However, we find no differential evidence of this change in borrower composition. We find that both EBA and non-EBA banks shift to firms with slightly lower Altman-Z-scores (i.e., higher risk), but they do not seem to modify their behavior in a different way. In particular, we find that the average firm that obtains a loan from an EBA bank has a pre-(post)- event Z-score of 1.94 (1.84). For the firms borrowing from non-EBA banks the pre-(post)- event Z-score was 1.69 (1.56).

Second, did EBA banks change their sovereign exposures in a manner different from the non-EBA banks? Banks relied on sovereign debt for collateral needs at the ECB. However, the EBA intervention penalized sovereign debt holdings. This can create incentives for banks to shift towards secured loans that can be easily turned into eligible collateral. We therefore study the evolution of banks' sovereign exposures before and after the event. We find that EBA and non-EBA banks change their sovereign holdings to a comparable extent, i.e., from 6.9 percent to 7.9 percent, and 4.1 percent to 4.9 percent, respectively. As the numbers suggest, this channel cannot explain our findings.¹⁹

Third, we want to quantify the importance of the increased collateral requirements to banks for reducing risk-weighted assets (RWA) compared to the reduction in RWA by cutting new lending. Indeed, there has been both a deleveraging (identified also in earlier work, such as Gropp, Mosk, Ongena, and Wix, 2019), as well as a reduction in the risk-weights of the assets, which we quantify in our paper. We take two steps to quantify this for *all corporate loans* and for *new corporate loans*, respectively. For all corporate loans, we studied how the total outstanding corporate loans as reported in the credit registry evolved for treated versus non-treated banks, and how their RWA evolved. These results show that EBA banks decreased their total assets by 1.79 percent while control banks by 1.87 percent. When it comes to RWA, however, the treated group decreased by 3.10 percent while the control by 2.31 percent only. These results would suggest that for corporate loans the reduction in

¹⁹See also Blattner, Farinha, and Rebelo, 2018

RWA relative to the control banks entirely stems from the risk-weights modifications (i.e., collateral and collateral composition) The no-differential impact for the two groups for total assets is also in line with the findings in Bidder, Krainer and Shapiro (2018). Of course, this exercise does not allow to control for firm demand.

For *new corporate loans* and using estimates from Tables 4, 5, and D1, our empirical results show an overall drop in new RWA of 10.1% of which 5.6% stems from deleveraging (i.e., reduction in assets) and 4.5% from increased collateralization, implying that in magnitude the latter is equal to 80% of the deleveraging channel (i.e., $4.5/5.6$). More details are provided in Appendix E.

5 Parallel Trends and Robustness

In this section, we first discuss the validity of the parallel trends assumption. Later we turn to several robustness tests related to our first two hypotheses.

5.1 Validity of the parallel trends assumption

In this subsection we discuss the validity of the underlying assumption of parallel trends in our diff-in-diff analysis. For this purpose, we study the lead-up to 2011 and examine how the lending activity of the treated and control banks differed in terms of their collateral requirements.

A diff-in-diff analysis relies upon the assumption that parallel trends hold: absent our

treatment, the average collateralization for the affected and control banks would have followed parallel paths over time. This assumption cannot be tested. However, the assumption also implies that collateralization of loans across the two groups should have a similar trend in the pre-treatment period. If not, our results above could reflect the dissimilar trend already observed in the run up to the treatment. This ‘making-feel-good’ exercise about parallel trends is particularly important due to the volatile environment before 2011. In April 2010, when the Greek government requested an EU/IMF bailout package, markets started to doubt the sustainability of the sovereign debt. Shortly afterward, investors began to be concerned about the solvency and liquidity of the public debt issued by the troubled countries, including Portugal. The higher sovereign risk since early 2010 in the Euro area dramatically increased the cost of some euro area, including Portuguese, banks’ funding costs. Yet, the size of the impact has been generally proportional to the deterioration in the creditworthiness of the domestic sovereign.

In Table F3 in Appendix F, we analyze the rate of loan collateralization by all banks in *non-EBA* periods during 2009-2010, i.e., covering windows before the EBA Capital Exercise. We show that there is no change in the use of collateral by treatment versus control banks in our pre-event periods. The table overall lends strong support to the validity of the assumption: all in all, in the absence of treatment during the period leading to the EBA, we find no difference between treatment and control groups in the outcome variable: collateral dummy.

5.2 Robustness tests

We start with robustness exercises related to our first hypothesis on the likelihood of collateral being pledged for new loans. To conserve space, we report these results for *relationship length* only in Table F4 in Appendix F.²⁰ In particular, we first check that our results are not sensitive to adding non-Portuguese European affected subsidiaries to our dataset. Our results continue to hold qualitatively, and are comparable in magnitude: in both columns, we see that treated banks increase collateral by 3.1 to 3.7 percentage points (about 7 percent of the unconditional mean) more after the treatment. At the same time, a borrower with an average relationship length sees the impact muted with about 45 percent compared to a transactional borrower at a treated bank (i.e., $0.037 - 0.004 \cdot \ln(64) = 0.020$), based on column 1).

Second, the EBA Capital Exercise was conducted for the largest banks in different European countries. Thus, on average the EBA Capital Exercise affected larger and significant financial institutions in each jurisdiction. A potential concern could be that this exercise only affects large banks and hence the results could be influenced by bank size or other unobservable factors that change differently for large and small banks. This concern is partly resolved in the diff-in-diff setting to the extent that any unobservable *changes* affecting the EBA (larger) banks are not different from those affecting the control group, and the inclusion of bank size as a control variable. To further mitigate the concern that our results are driven

²⁰Our results are quantitatively similar for the cumulative relationship measure.

by bank size (or the unobservable factors that change differently for large and small banks), we create a *matched control* sample of banks containing the 4 largest non-treated domestic banks in Portugal. These non-treated banks are by design smaller than the treated ones.

The descriptives of the *matched control* banks are shown in Table 2. We learn that after matching, *treated* and *matched control* banks are much more comparable in terms of asset size, but by design the control banks remain smaller.²¹ When restricting our sample of control firms dealing with banks from this matched control group, we find that results are only slightly attenuated compared to our main analysis (see columns 3 and 4 of Table F4 in Appendix F). This is to be expected to the extent that larger banks might lend to larger borrowers with whom they maintain longer lending relationships and are more likely to be the main lender, and where therefore the treatment effects are somewhat less outspoken in comparison.

²¹We also considered a regression discontinuity design (RDD). However, we see major drawbacks for its applicability in our setting. It indeed holds that the EBA Capital Exercise leads to a cut-off in terms of size for a domestic bank to be included in the exercise or not. In particular a domestic Portuguese bank is included when, starting from the largest bank, the smallest bank added to the exercise covers at least 50 percent of domestic banking assets. The ‘running variable’ therefore is total assets/size of marginal bank. The RDD estimator estimates the treatment effect at the cutoff and gives zero or little weight to the observation further away from the cutoff. The main identifying assumption is the ‘continuity assumption’ that banks are similar in characteristics around the threshold. This requires a substantial mass of banks in a bandwidth around the size threshold, for the local average treatment effect to be estimated. This assumption is problematic in our setup. Normalizing the running variable (total assets / cutoff) we see that the largest control bank is much smaller than the smallest treated bank.

If we employ a bandwidth as in Gropp, Mosk, Ongena, and Wix (2019) (who study the EBA Capital Exercise on a European sample of banks), we see that only one control bank falls in their optimal bandwidth. A smaller bandwidth reduces the sample and the support of covariates to control for cross-sectional heterogeneity in bank characteristics around the threshold. Furthermore, an additional degree of complexity that hinders a direct implementation of RDD is that our analysis is at the firm-bank level (i.e., loan level) for firms taking loans from two banks in order to control for firm demand using fixed effects as in Khwaja and Mian (2008). We therefore abstained from using an RDD approach.

Up until now we have only focused on firms with multiple lending relationships. As a robustness, we include firms with single-bank relationships (see column 5). Since we cannot use firm level fixed effects for this specification, we follow Degryse, De Jonghe, Jakovljevic, Mulier, and Schepens (2019), and employ industry-location-size (ILS) clusters to control for firm demand. In particular, we create bins based on a 2-digit industry classification (77 industries), 22 districts, and 4 size bins (micro, small, medium, and large). This gives us 2100 non-empty ILS bins. We confirm that the results continue to hold qualitatively. While the double coefficient effect is somewhat smaller, the effect on relationship borrowers remains quantitatively robust, too.

Given that our event window overlaps with ECB’s longer-term refinancing operations, we further provide robustness checks to rule out that our results are contaminated with the effects of the operations. We have bank-level information on the amounts received through the operations for all banking groups that benefited from the program. Normalizing it by total asset size, we either add the ratio as a control in the specification (see column 6), restrict the sample till the end of 2011 (see column 7), the beginning of LTRO (December 21, 2011).²²

Finally, we present results without any foreign bank presence (see column 8). We wanted to make sure our results are not contaminated by the presence of foreign banks. In our

²²Gropp, Mosk, Ongena, and Wix (2019) also show that the results are not affected by banks benefiting from LTRO. Jasova, Mendicino and Supera (2019) find that LTRO exposure is unrelated to banks’ size, capital ratio, leverage and equity ratios. Crosignoni, Faria-e-Castro, and Fonseca (2015) further show that the number of domestic Portuguese banks with liabilities from the Eurosystem is stable around the EBA Capital Exercise.

baseline specifications, we had already excluded foreign treated banks. We further drop foreign banks from our control group to account for any other unobservable factors that may potentially confound our treatment. Column 8 shows the results and confirms statistically significant, and economically slightly smaller magnitude of the double and triple effects.

We also perform similar robustness tests regarding our second hypothesis on the usage of *low risk weight collateral*. We again indicate the type of robustness exercise on top of each column. Our dependent variable is now *low risk weight collateral* as in Table F2 and the sample covers only collateralized loans. All results are presented in Table F5 in Appendix F. Our results are robust to these alterations.

6 Sector and firm level outcomes

In this section we study whether the increased collateral requirements imposed by treated banks affected firms and sectors in terms of credit allocation, investment decisions, and growth. We first investigate **H3, A**: increased collateral requirements cause credit reallocation from sectors with few pledgeable assets to those with more pledgeable assets. Second, we test **H3, B**: do increased collateral requirements tilt firms' investments towards fixed or tangible assets and lead to less growth.

6.1 Sector-level outcomes

We first investigate whether sectors with a high share of intangible assets (and thus a low share of pledgeable assets) who were borrowing more intensively from EBA banks were affected differently than otherwise similar sectors during the period of the EBA Capital Exercise. Our identification strategy resembles the one of Rajan and Zingales (1998). We measure sectoral intangibility (*Share intan*) (and thus firm-level intangibility) by using end 2010 firm-level balance sheet information, and create a size-weighted average at the sector level. We rely upon 4 digit NACE classification to identify sectors, leading to 523 sectors with data available. Similarly, we define a dummy *Eba high* that takes the value of one for sectors with above median exposure to treated banks: the exposure here is the sectoral level ratio of total loan volume extended by treated banks over total loan volume extended by all banks, again measured at the end of 2010.

Our empirical model becomes:

$$y_{s,t} = \alpha + \beta * Share\ intan_{s,t-1} + \gamma * Share\ intan * Eba\ high_{s,t-1} + \eta * Eba\ high_{s,t-1} + \nu * controls_{s,t-1} + \epsilon_{s,t} \quad (5)$$

where $y_{s,t}$ captures sector s 's lending growth, employment growth, and asset growth from the end of 2010 to the end of 2012.

We first test whether *sectoral lending growth* for firms having obtained loans is sensitive

to a sector's intangibility ratio and its exposure to EBA banks. Our hypothesis is that sectors with greater intangibility that are more exposed to treated banks will be more heavily affected in terms of contraction of lending, i.e., we expect that the coefficient on the interaction term $Share\ intan * Eba\ high$ is negative. In Columns 1 and 2 of Table 10 we observe that sectors with higher $Share\ intan$ are affected more adversely over the period 2010 to 2012. The interaction term $Share\ intan * Eba\ high$ is negative and statistically significant in most specifications. Based on column 1, a one-standard-deviation increase in $Share\ intan$ (19.3 percent) leads to a 20.6 pp lower sectoral lending growth when EBA banks are the major lenders to the sector (i.e., $(-0.413-0.658)*0.193$) versus a 7.9 pp lower growth when EBA banks are not the major lender (i.e., $-0.413*0.193$).²³ The remaining columns in Table 10 focus on real outcomes at sectoral level. Columns 3 and 4 (5 and 6), show effects on employment (fixed assets) growth at the sectoral level. Our identification strategy again relies on comparing sectors with similar intangibles but that are more or less exposed to the EBA shock. In terms of magnitude, the interaction effect shows that a one-standard-deviation increase in $Share\ intan$ leads to a 4.8 (7.1) pp drop when $Eba\ high = 0$ versus 10.4 (16.4) pp drop when $Eba\ high = 1$ in employment (asset) growth.

²³This result is complementary to Dell'Ariccia, Kadyrzhanova, Minoiu, and Ratnovski, 2018, who show that increased intangible investments by firms has led banks to reallocate towards the commercial and residential real estate sector. As we do not analyze the real estate sector, the latter finding suggests that the overall sectoral reallocation effect is more pronounced.

6.2 Firm-level outcomes

We now proceed to the firm level and analyze the impacts of the EBA Capital Exercise on firm-level outcomes. To study these outcomes, we divide firms into three categories based upon their status before the shock: those borrowing only from EBA banks (dummy *borrower treated* equal to one), those borrowing from both groups of banks (*borrower both* equal to one), and those that borrow only from control banks (the base case). The main idea of this approach is that *borrower treated* firms (and possibly to a lesser extent *borrower both* firms) are exposed to tightened conditions and may have fewer alternatives, compared to firms that only borrow from control banks. As in our main analysis, we only include firms with multiple relationships that obtained new loans.

Our empirical model becomes:

$$y_{i,t} = \alpha + \beta * Borrower\ treated_{i,t-1} + \gamma * Borrower\ both_{i,t-1} + \eta * controls_{i,t-1} + \epsilon_{i,t} \quad (6)$$

where $y_{i,t}$ captures proxies for firm i 's real and financial outcomes from end 2010 to end 2012.

Columns 1 to 6 of table 11 present our results for different firm-level outcomes: employment growth, asset growth, change in tangible asset ratio (delta tan), change in interest

rate (delta rate), turnover growth and inventory growth.²⁴ Columns 7 to 12 add two-digit NACE sector FE compared to columns 1 to 6. A potential worry for asset growth or tangible asset changes could be that they can be easily manipulated by firms, their auditors or banks in order to enable credit flowing to the firm. We therefore include other variables such as employment growth, inventory growth, and turnover growth which are less subject to such possible manipulations. Columns 2 and 8 show that *borrower treated* and *borrower both* firms exhibit a smaller asset growth than firms borrowing from control banks. *Borrower treated* firms experience a 1.8 to 2.1 percentage point decline in asset growth (columns 2 and 8), which is about 3.5 percent of its variation. *Borrower both* firms also see a decline but with a slightly smaller economic magnitude in line with the idea that they are somewhat less exposed to the EBA Capital Exercise. Columns 1 and 7 indicate some negative impact of the treatment on employment growth, but for *Borrower both* firms it is significant only in column 5. In columns 3 and 9 we test whether the *borrower treated* firms modify their investments towards tangible assets, that are easier to pledge as collateral. We find that treated groups increase their tangible asset ratio by 0.4 percentage points, which is about 40 percent of the average change in tangible asset ratio, and accounts for 4 percent of its standard deviation. Also firms borrowing from both groups of banks tilt their individual investment decisions towards tangible assets with about the same magnitude, suggesting that such firms find it difficult to adjust their investment behavior even when having non-affected

²⁴The precise definition of inventory used here is raw materials and intermediate goods used in the production process, excluding final products. A shrinking firm will require less raw inputs and is hence an indicator of negative real effects (Buera and Karmakar, 2019; Shourideh and Zeltin-Jones, 2017).

banks among their lenders. Finally, columns 4 and 10 (5 and 11) show that those firms experience a negative turnover growth as well as a negative inventory growth by about 5 percentage points, explaining 10 percent of the variation in turnover growth (9 percent in inventory growth).

Could it be that increased collateral requirements are accompanied by reduced interest rates, to compensate borrowers for the stricter collateral requirements? This is a more likely scenario for competitive environments since borrowers may switch to a control bank that has not increased collateral requirements. However, depending on the magnitude of switching frictions, the pass-through to interest rates may be more moderate. While we do not have data on interest rates at the loan level, we use firm balance sheet and income statement information to calculate a proxy for the interest rate. We obtain this interest rate by dividing annual interest paid by the average of current and previous end-of-year outstanding debt. *Delta rate* is the change in this interest rate proxy over the period 2010 to 2012. Columns 4 and 8 show economically small and statistically insignificant effects.

7 Conclusion

We exploit a quasi-natural experiment that changed the relative cost of extending collateralized loans compared to uncollateralized ones. In particular, in October 2011 the European Banking Authority imposed stricter capital requirements on some major European banking groups as a result of risks linked to their sovereign bond holdings. This exogenous variation

favors collateralized lending by the treated banks relative to unsecured lending as collateralized loans carry lower risk weights and therefore require less regulatory capital to be withheld against them. Using detailed loan-level data and a difference-in-difference-in-differences approach, we find that treated banks in general are 3-5 percentage points (6-10 percent) more likely to require collateral. However, for relationship borrowers (those with average relationship length), the treated banks' increase in required collateralization is dampened by about 25 percent. Furthermore, following the quasi-natural experiment, treated banks were requiring collateral that saved more on regulatory capital than control banks, but again partially shield their relationship borrowers.

Banks have several margins to adjust to higher capital requirements. Next to raising new capital or deleveraging, our paper documents a collateralization effect of higher capital requirements. In particular, banks change the composition of lending towards collateralized loans. While cutting lending is an important driver of lowering banks' risk-weighted assets, increased collateral requirements are economically relevant as it contributes about 45% in the total reduction of risk-weighted assets stemming from new corporate lending.

Our findings suggest that the impact of higher capital requirements through increased collateralization is muted for relationship borrowers. For borrowers that have insufficient supply of collateral, this suggests a relative increase in access to credit when having strong bank-firm relationships. In sum, we show that relationship banking is an empirically important driver of collateral decisions also in environments with stricter capital requirements.

To conclude, our paper has implications for a recent policy debate regarding banks' use of collateral versus screening. In a recent speech²⁵, the Governor of the Bank of Portugal highlighted that banks should alter the manner in which they assess loan applications. The banks should not only consider the availability of guarantees or collateral but also evaluate the viability of projects, i.e., better screening. Our analysis shows that capital requirements favoring collateralized lending may hamper such choice (but strong relationships may partially mitigate this). Such capital requirements also generate negative real effects for firms and sectors with lots of intangible assets. If switching to tangible sectors is done to save on regulatory capital, banks may lose some of valuable, long-standing customers with viable projects yet little collateral: in this case, capital requirements that assign lower risk weights to relationship customers may help preserve high-value projects.

²⁵Flexibilidade e proporcionalidade em corporate governance - A promoção do mercado de capitais (Português) através do corporate governance, 2017. International Conference of the Portuguese Securities Markets Commission. Speech of Governor of Bank of Portugal Carlos Costa.

Appendix

A Main Tables

Table 1: **Descriptive Statistics.** The table shows the mean and standard deviation of dependent variables, relationship variables and firm characteristics. Variable definitions are in Appendix B.

	Mean	Std. Dev.
Dependent variable		
Collateral	0.501	0.494
Collateral (Treated)	0.510	0.499
Collateral (Control)	0.472	0.491
Collateral (Treated pre)	0.477	0.499
Collateral (Treated post)	0.552	0.497
Collateral (Control pre)	0.455	0.497
Collateral (Control post)	0.490	0.498
Low risk weight collateral	0.240	0.432
Relationship variables (bank-level)		
Relationship length	44	19
Relationship length (Treated)	64	8
Relationship length (Control)	41	19
Cumulative relationship	17	8
Cumulative relationship (Treated)	26	4
Cumulative relationship (Control)	15	8
Firm variables: all firms		
Age	16.18	12.98
Total assets (thousand euros)	2413.32	5433.83
Number of employees	27.22	206.09
Number of banking relationships	2.58	1.02
Firm variables: treated banks only		
Age	17.32	13.48
Total assets (thousand euros)	2487.25	5500.29
Number of employees	28.85	244.23
Number of banking relationships	2.31	0.64
Firm variables: control banks only		
Age	12.93	10.97
Total assets (thousand euros)	1034.22	2690.49
Number of employees	12.62	69.34
Number of banking relationships	2.26	0.56
Firm variables: both		
Age	17.39	13.29
Total assets (thousand euros)	3357.29	6505.867
Number of employees	37.45	238.52
Number of banking relationships	3.18	1.34

Table 2: **Bank characteristics.** The table shows the mean and standard deviation of bank characteristics by bank status. The matched group consists of the treated banks and the 4 largest domestic control banks in terms of assets. Assets are in hundreds of million of Euros.

Bank characteristics	Mean	Std. Dev.
Assets (Treated)	20.6	8.80
Assets (Control)	2.03	4.20
Assets (Matched)	8.84	9.24
Liquidity Ratio (Treated)	0.092	0.021
Liquidity Ratio (Control)	0.072	0.143
Liquidity Ratio (Matched)	0.080	0.028
Capital Ratio (Treated)	0.077	0.045
Capital Ratio (Control)	0.081	0.103
Capital Ratio (Matched)	0.106	0.09

Table 3: **EBA Capital Exercise and loan collateralization.** The table shows the results for Equation (1). The dependent variable is *collateral dummy*. *Treated* is a dummy equal to 1 for Portuguese banks that were affected by EBA Capital Exercise and 0 otherwise. The pre-shock period is Q1 and Q2 of 2011. *Post* is an indicator variable which is equal to 1 for quarters after the implementation date. The *Post* window is indicated on top of each column. Column 1 considers the immediate impact of the shock (Q4:2011 and Q1:2012, i.e., Q4,Q1) while the other columns allow for a quarter of adjustment (Q1 and Q2 of 2012, i.e., Q1,Q2). Variable definitions are in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan Volume*). Standard errors are clustered at the bank level.

	[1] Q4,Q1	[2] Q1,Q2	[3] Q1,Q2	[4] Q1,Q2
<i>Post * Treated</i>	0.051*** [0.002]	0.039*** [0.002]	0.031*** [0.002]	0.039*** [0.003]
<i>Loan volume</i>	0.140*** [0.000]	0.141*** [0.000]	0.150*** [0.000]	0.151*** [0.000]
Bank FE	Y	Y	Y	Y
Firm FE	N	N	Y	N
Firm Time FE	N	N	N	Y
R-squared	0.38	0.38	0.56	0.59
Number of obs.	525558	498742	498742	492929

Table 4: **EBA Capital Exercise and collateralization rate.** The table shows the results for Equation (2). The dependent variable is the *collateralization rate*, i.e., *the ratio of collateralized loans over all loans*, measured at the firm-bank-month level. *Treated* is a dummy equal to 1 for Portuguese banks that were affected by EBA Capital Exercise and 0 otherwise. *Post* is an indicator variable which is equal to 1 for quarters after the implementation date. The *Post* window is indicated on top of each column. Columns 1 and 2 focus only on new loans, while 3 and 4 focus on existing loans only. All columns consider Q1 and Q2 of 2012 as post period. Variable definitions are in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. Standard errors are clustered at the bank level.

	[1]	[2]	[3]	[4]
	New Loans	New Loans	Old Loans	Old Loans
<i>Post * Treated</i>	0.043*** [0.008]	0.035*** [0.010]	-0.001 [0.001]	-0.004*** [0.001]
Bank FE	Y	Y	Y	Y
Firm FE	Y	N	Y	N
Firm Time FE	N	Y	N	Y
R-squared	0.36	0.44	0.46	0.50
Number of obs.	297475	303062	1691087	1766179

Table 5: **EBA Capital Exercise and loan collateralization: relationship versus transactional borrowers.** The table shows the results for Equation (3). The dependent variable is *collateral dummy*. *Relationship Length* is the elapsed relationship time (measured in log of months) since the first interaction between a bank and a firm. *Cum. relationship* measures the (log of) cumulative number of interactions. *Treated* is a dummy equal to 1 for Portuguese banks that were affected by EBA Capital Exercise and 0 otherwise. In columns 1-4, our independent variable is *relationship length* whereas columns 5-8 use the *cum. relationship* as the main independent variable. The pre-shock period is Q1 and Q2 of 2011. *Post* is an indicator variable which is equal to 1 for quarters after the implementation date. The *Post* window is indicated on top of each column. Columns 1 and 5 consider the immediate impact of the shock (Q4:2011 and Q1:2012, i.e., Q4,Q1) while the other columns allow for a quarter of adjustment (Q1 and Q2 of 2012, i.e., Q1,Q2). Variable definitions in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan volume*). Standard errors are clustered at the bank level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>RelationshipLength</i>	Q4,Q1	Q1,Q2	Q1,Q2	Q1,Q2	Q4,Q1	Q1,Q2	Q1,Q2	Q1,Q2
	-0.030*** [0.001]	-0.029*** [0.001]	-0.028*** [0.001]	-0.032*** [0.002]				
<i>RelationshipLength * Treated</i>	0.018*** [0.002]	0.018*** [0.002]	0.007** [0.003]	0.007** [0.003]				
<i>RelationshipLength * Post</i>	0.010*** [0.002]	0.014*** [0.002]	0.013*** [0.002]	0.012*** [0.002]				
<i>RelationshipLength * Post * Treated</i>	-0.012*** [0.003]	-0.016*** [0.003]	-0.011*** [0.003]	-0.013*** [0.003]				
<i>Post * Treated</i>	0.030*** [0.011]	0.034*** [0.011]	0.011 [0.011]	0.030** [0.013]				
<i>Cum. relationship</i>					0.039*** [0.010]	0.040*** [0.010]	0.009 [0.010]	0.026** [0.012]
<i>Cum. relationship * Treated</i>					-0.060*** [0.002]	-0.059*** [0.002]	-0.061*** [0.002]	-0.065*** [0.002]
<i>Cum. relationship * Post</i>					0.009*** [0.003]	0.009*** [0.003]	0.002 [0.003]	0.010*** [0.003]
<i>Cum. relationship * Post * Treated</i>					0.010*** [0.002]	0.015*** [0.002]	0.015*** [0.002]	0.013*** [0.003]
<i>Loan volume</i>					-0.017*** [0.003]	-0.022*** [0.003]	-0.013*** [0.003]	-0.015*** [0.004]
Bank FE	0.141*** [0.000]	0.141*** [0.000]	0.150*** [0.000]	0.150*** [0.000]	0.141*** [0.000]	0.141*** [0.000]	0.150*** [0.000]	0.151*** [0.000]
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm Time FE	N	N	N	N	N	N	N	N
R-squared	0.41	0.41	0.58	0.61	0.41	0.41	0.58	0.61
Number of obs.	525558	498742	497162	518501	525558	498742	497162	518501

Table 6: **EBA Capital Exercise and loan collateralization: intensity of treatment.** The table shows the results for Equation (3) where the treatment is captured by its intensity (*Shortfall*). The dependent variable is *collateral dummy*. *Shortfall* is the percentage shortfall of capital (as a fraction of risk-weighted assets) for Portuguese banks that were treated by EBA Capital Exercise. In columns 1-4, our independent variable is *relationship length* whereas columns 5-8 use the *cum. relationship* as the main independent variable. The pre-shock period is Q1 and Q2 of 2011. *Post* is an indicator variable which is equal to 1 for quarters after the implementation date. As indicated on the top of the columns, columns 1 and 5 consider the immediate impact of the shock (Q4:2011 and Q1:2012, i.e., Q4,Q1) while the other columns allow for a quarter of adjustment (Q1 and Q2 of 2012, i.e., Q1,Q2). Variable definitions in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan volume*). Standard errors are clustered at the bank level.

	(1) Q4,Q1	(2) Q1,Q2	(3) Q1,Q2	(4) Q1,Q2	(5) Q4,Q1	(6) Q1,Q2	(7) Q1,Q2	(8) Q1,Q2
<i>RelationshipLength</i>	-0.028*** [0.001]	-0.026*** [0.001]	-0.026*** [0.001]	-0.029*** [0.002]				
<i>RelationshipLength * Shortfall</i>	0.003*** [0.001]	0.003*** [0.001]	0.001 [0.001]	0.001* [0.001]				
<i>RelationshipLength * Post</i>	0.008*** [0.002]	0.010*** [0.002]	0.010*** [0.002]	0.012*** [0.002]				
<i>RelationshipLength * Post * Shortfall</i>	-0.002*** [0.001]	-0.003*** [0.001]	-0.002*** [0.001]	-0.004*** [0.001]				
<i>Post * Shortfall</i>	0.004* [0.003]	0.007** [0.003]	0.004 [0.003]	0.009** [0.004]	0.006** [0.003]	0.009*** [0.003]	0.004 [0.003]	0.011*** [0.003]
<i>Cum. relationship</i>					-0.058*** [0.002]	-0.056*** [0.002]	-0.058*** [0.002]	-0.061*** [0.002]
<i>Cum. relationship * Shortfall</i>					0.002*** [0.001]	0.002*** [0.001]	-0.000 [0.001]	0.001 [0.001]
<i>Cum. relationship * Post</i>					0.006*** [0.002]	0.009*** [0.002]	0.011*** [0.002]	0.014*** [0.003]
<i>Cum. relationship * Post * Shortfall</i>					-0.003*** [0.001]	-0.004*** [0.001]	-0.003*** [0.001]	-0.005*** [0.001]
<i>Loan volume</i>	0.141*** [0.000]	0.141*** [0.000]	0.150*** [0.000]	0.150*** [0.000]	0.141*** [0.000]	0.141*** [0.000]	0.150*** [0.000]	0.151*** [0.000]
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	N	N	Y	N	N	N	Y	N
Firm Time FE	N	N	N	Y	N	N	N	Y
R-squared	0.41	0.41	0.58	0.60	0.41	0.41	0.58	0.61
Number of obs.	525558	498742	497162	492929	525558	498742	497162	492929

Table 7: **The EBA Capital Exercise and collateral type: relationship versus transactional borrowers.** The table shows the results for Equation (4). The dependent variable *low risk weight collateral* is an indicator variable taking the value of 1 if collateral type is real estate, a guarantee backed by government or a financial institution, or if it is financial collateral. The dummy takes value 0 if the loan is collateralized by other collateral. The sample only includes collateralized loans. *Treated* is a dummy equal to 1 for Portuguese banks that were affected by EBA Capital Exercise and 0 otherwise. The pre-EBA window is Q1 and Q2 of 2011. Columns 1 and 5 use Q4:2011 and Q1:2012 as the post or treatment period (i.e., Q4,Q1 as indicated on top of the column). The other columns use Q1 and Q2 of 2012 as the post or treatment period (i.e., Q1,Q2 as indicated on top of the column). Columns 1-4 (5-8) present results for equation 3. Variable definitions in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan volume*). Standard errors are clustered at the bank level.

	(1) Q4,Q1	(2) Q1,Q2	(3) Q1,Q2	(4) Q1,Q2	(5) Q4,Q1	(6) Q1,Q2	(7) Q1,Q2	(8) Q1,Q2
<i>RelationshipLength</i>	-0.029*** [0.001]	-0.033*** [0.001]	-0.028*** [0.002]	-0.026*** [0.002]				
<i>RelationshipLength * Treated</i>	0.045*** [0.001]	0.053*** [0.001]	0.057*** [0.001]	0.059*** [0.001]				
<i>RelationshipLength * Post</i>	0.042*** [0.003]	0.036*** [0.003]	0.020*** [0.003]	0.024*** [0.004]				
<i>RelationshipLength * Post * Treated</i>	-0.085*** [0.004]	-0.088*** [0.003]	-0.053*** [0.004]	-0.072*** [0.005]				
<i>Post * Treated</i>	0.345*** [0.018]	0.337*** [0.013]	0.195*** [0.015]	0.269*** [0.018]	0.381*** [0.014]	0.371*** [0.010]	0.252*** [0.011]	0.327*** [0.014]
<i>Cum. relationship</i>					-0.057*** [0.001]	-0.063*** [0.002]	-0.051*** [0.002]	-0.046*** [0.002]
<i>Cum. relationship * Treated</i>					0.053*** [0.001]	0.064*** [0.001]	0.068*** [0.002]	0.072*** [0.002]
<i>Cum. relationship * Post</i>					0.059*** [0.003]	0.056*** [0.003]	0.037*** [0.003]	0.041*** [0.004]
<i>Cum. relationship * Post * Treated</i>					-0.118*** [0.004]	-0.121*** [0.003]	-0.085*** [0.004]	-0.108*** [0.005]
<i>Loan volume</i>	0.022*** [0.001]	0.023*** [0.001]	0.018*** [0.001]	0.018*** [0.001]	0.023*** [0.001]	0.023*** [0.001]	0.018*** [0.001]	0.018*** [0.001]
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	N	N	Y	N	N	N	Y	N
Firm-time FE	N	N	N	Y	N	N	N	Y
R-squared	0.07	0.08	0.32	0.35	0.07	0.07	0.31	0.35
Number of obs.	335212	318704	315774	309911	335212	318704	315774	309911

Table 8: **Full Implementation of EBA Capital Exercise and loan collateralization: relationship versus transactional borrowers.** The table shows the results for Equation (3). The dependent variable is *collateral dummy*. *Relationship Length* is the elapsed relationship time (measured in log of months) since the first interaction between a bank and a firm. *Post* is an indicator variable which is equal to 1 for quarters after the deadline, i.e., Q3 and Q4 of 2012. Columns 1 and 2 consider Q1 and Q2 of 2012 as the pre-period while Q3 and Q4 of 2012 as the post period. Columns 5 and 6 consider the overall impact, from pre-period (Q1 and Q2 of 2011) to the post-period (Q3 and Q4 of 2012). Variable definitions are in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan volume*). Standard errors are clustered at the bank level.

	[1]	[2]	[3]	[4]
	Pre: Q1,Q2 2012 Post: Q3,Q4 2012	Pre: Q1,Q2 2012 Post: Q3,Q4 2012	Pre: Q1,Q2 2011 Post: Q3,Q4 2012	Pre: Q1,Q2 2011 Post: Q3,Q4 2012
<i>RelationshipLength</i>	-0.002 [0.002]	-0.006*** [0.002]	-0.028*** [0.001]	-0.031*** [0.002]
<i>RelationshipLength * Treated</i>	0.017*** [0.003]	0.016*** [0.004]	0.008*** [0.003]	0.009*** [0.003]
<i>RelationshipLength * Post</i>	0.006*** [0.002]	0.013*** [0.003]	0.025*** [0.002]	0.030*** [0.002]
<i>RelationshipLength * Post * Treated</i>	-0.002 [0.003]	-0.004 [0.004]	-0.016*** [0.003]	-0.021*** [0.003]
<i>Post * Treated</i>	-0.016 [0.012]	-0.004 [0.015]	0.015 [0.011]	0.030** [0.014]
<i>Loan volume</i>	0.148*** [0.000]	0.148*** [0.000]	0.149*** [0.000]	0.150*** [0.000]
Bank FE	Y	Y	Y	Y
Firm FE	Y	N	Y	N
Firm Time FE	N	Y	N	Y
R-squared	0.55	0.59	0.57	0.60
Number of obs.	435760	430171	488146	482280

Table 9: **Full Implementation of EBA Capital Exercise and collateral type: relationship versus transactional borrowers.** The table shows the results for Equation (4). The dependent variable is *low risk weight collateral*. It is an indicator variable taking the value of 1 if the collateral type is real estate, a guarantee backed by government or a financial institution, or if it is financial collateral. The dummy takes value 0 otherwise. The sample only includes collateralized loans. *Post* is an indicator variable which is equal to 1 for quarters after the deadline, i.e., Q3 and Q4 of 2012. Columns 1 and 2 consider Q1 and Q2 of 2012 as the pre-period while Q3 and Q4 of 2012 as the post period. Columns 5 and 6 consider the overall impact, from pre-period (Q1 and Q2 of 2011) to the post-period (Q3 and Q4 of 2012). Variable definitions are in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan volume*). Standard errors are clustered at the bank level.

	[1]	[2]	[3]	[4]
	Pre: Q1,Q2 2012 Post: Q3,Q4 2012	Pre: Q1,Q2 2012 Post: Q3,Q4 2012	Pre: Q1,Q2 2011 Post: Q3,Q4 2012	Pre: Q1,Q2 2011 Post: Q3,Q4 2012
<i>RelationshipLength</i>	-0.005*** [0.002]	0.001 [0.001]	-0.028*** [0.003]	-0.024*** [0.003]
<i>RelationshipLength * Treated</i>	0.002 [0.008]	0.003 [0.008]	0.060*** [0.004]	0.060*** [0.004]
<i>RelationshipLength * Post</i>	-0.015*** [0.002]	-0.025*** [0.002]	-0.005** [0.002]	-0.008** [0.003]
<i>RelationshipLength * Post * Treated</i>	-0.004*** [0.000]	-0.004*** [0.001]	-0.044*** [0.003]	-0.057*** [0.004]
<i>Post * Treated</i>	0.033 [0.026]	0.031 [0.026]	0.127*** [0.012]	0.180*** [0.012]
<i>Loan volume</i>	0.013*** [0.001]	0.013*** [0.001]	0.022*** [0.001]	0.021*** [0.001]
Bank FE	Y	Y	Y	Y
Firm FE	Y	N	Y	N
Firm Time FE	N	Y	N	Y
R-squared	0.28	0.32	0.30	0.34
Number of obs.	277797	271548	305966	300099

Table 10: **EBA Capital Exercise and sectoral level outcomes.** The table shows the results for Equation (5). The dependent variable is measured at the 4-digit NACE classification sectoral level. It is the lending growth (between end 2012 and end 2010) in columns 1 and 2. In columns 3 and 4, the dependent variable is the sectoral employment growth while in columns 5 and 6, it is the total sectoral asset growth. *Eba high* takes a value of one for sectors with above median exposure (66%) to treated banks, and zero otherwise, as of end 2010. *Share intan* is the share of intangible assets to total assets in each sector measured before the event window. Columns 1, 3, and 5 (2,4 and 6) show OLS (WLS) regression results.

	(1)	(2)	(3)	(4)	(5)	(6)
	sect lending	sect lending	emp growth	emp growth	asset growth	asset growth
<i>Share intan</i>	-0.412*** [0.130]	-0.431*** [0.124]	-0.174* [0.100]	-0.248*** [0.092]	-0.252** [0.104]	-0.369*** [0.097]
<i>Share intan * Eba high</i>	-0.658*** [0.183]	-0.676*** [0.180]	-0.126 [0.141]	-0.290** [0.131]	-0.243* [0.146]	-0.483*** [0.138]
<i>Eba high</i>	0.061 [0.139]	0.062 [0.139]	0.120 [0.130]	0.107 [0.128]	0.082 [0.131]	0.063 [0.129]
R-squared	0.06	0.07	0.06	0.09	0.05	0.08
Number of obs.	523	523	523	523	523	523

Table 11: **EBA Capital Exercise and firm-level outcomes.** The table shows results of Equation (6). *Borrower treated* is an indicator variable taking value of one if all banks of the borrower are treated banks. *Borrower both* takes value one if among the firm borrows from treated and control banks. *Emp growth* and *asset growth* are firm level employment and asset growth from 2010 to 2012, respectively. *Delta tan* is defined as the change in tangible asset ratio, *Delta rate* is the change in interest rate proxy. Sectoral fixed effects at two digit NACE code level (columns 5 to 8) and additional firm controls are included in the specifications. At the firm level, we control for firm size, age, and profitability.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
	emp growth	asset growth	delta tan	delta rate	turnover growth	inventory growth	emp growth	asset growth	delta tan	delta rate	turnover growth	inventory growth
<i>Borrower treated</i>	0.001 [0.005]	-0.018*** [0.005]	0.004*** [0.001]	-0.001 [0.001]	-0.048*** [0.006]	-0.045*** [0.006]	-0.004 [0.005]	-0.021*** [0.005]	0.005*** [0.001]	-0.001 [0.001]	-0.058*** [0.006]	-0.052*** [0.006]
<i>Borrower both</i>	-0.004 [0.006]	-0.010* [0.006]	0.004** [0.002]	0.001 [0.001]	-0.042*** [0.007]	-0.041*** [0.007]	-0.013** [0.006]	-0.015*** [0.006]	0.005*** [0.002]	0.001 [0.001]	-0.051*** [0.007]	-0.049*** [0.007]
<i>Loan volume</i>	0.003** [0.001]	0.008*** [0.001]	0.002*** [0.000]	0.001*** [0.000]	-0.001 [0.002]	-0.005*** [0.002]	0.003** [0.001]	0.005*** [0.001]	0.002*** [0.000]	0.001*** [0.000]	-0.001 [0.002]	-0.005*** [0.002]
Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector FE	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y
R-squared	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.02	0.01	0.01	0.06	0.06
Number of obs.	43652.00	43670.00	43110.00	37254.00	44568.00	38570.00	43652.00	43670.00	43110.00	37254.00	44568.00	38570.00

B Appendix B: Variable Definitions

Variable	Source	Description
Collateral Dummy	CRC	A dummy that takes a value of 1 if collateral is pledged, on a new loan, within a firm-bank pair in a given month & 0 otherwise.
Low risk weight collateral	CRC	A dummy equal to 1 if loan is collateralized by real estate, a guarantee backed by government or a financial institution, or financial collateral, and 0 if other type of collateral is pledged within a firm-bank pair in a given month.
Relationship Length	CRC starting 2005	Number of months since first loan with bank. Raw data in descriptives table. Ln in the regressions.
Cumulative Relationship	CRC starting 2005	Number of times a new loan has been granted up to loan origination. Raw data in descriptives table. Ln (1+) in the regressions.
Loan volume	CRC	Log of outstanding credit in a firm-bank pair in a given month.
Max. banking relationships (Firm)	Constructed using CRC 2005-2013	Maximum number of banks a firm has had a relationship with
Age (Firm)	CBSD	Number of years since creation of the firm
Num. of employees (Firm)	CBSD	Number of employees on a firm's payroll during the given year.
Total assets (Firm)	CBSD	firm's total assets (in thousand Euro's) during the given year.
Profitability (Firm)	CBSD	EBITDA divided by total assets.
Total assets (Bank)	PD	Total assets of the bank reported at monthly frequency
Liquidity ratio (Bank)	PD	Cash and short-term securities (less than 1Y) normalized by total assets.
Capital ratio (Bank)	PD	Tier-1 core capital divided by risk-weighted assets.

C Appendix C: Risk-Weights

During our sample period the prudential requirements applied to credit institutions were defined by the Directive 2006/48/EC (the original CRD) with the changes introduced by the Directive 2009/111/EC (CRD II) and Directive 2010/76/EU (CRD III). In Portugal, the prudential rules of credit risk were published in the Notice No. 5/2007 of the Bank of Portugal (Aviso do Banco de Portugal, numero 5/2007). Most banks in Portugal use the Standardized approach. Under this approach, exposures or any part of an exposure fully and completely secured, to the satisfaction of the competent authorities, by mortgages on residential property which is or shall be occupied or let by the owner, or the beneficial owner in the case of personal investment companies, shall be assigned a risk weight of 35%.

In the case of exposures secured by mortgages on offices or other commercial premises situated within their territory may be assigned a risk weight of 50%. The 50% risk weight shall be assigned to the Part of the loan that does not exceed a limit calculated according to either of the following conditions: (a) 50% of the market value of the property in question; (b) 50% of the market value of the property or 60% of the mortgage lending value, whichever is lower, in those Member States that have laid down rigorous criteria for the assessment of the mortgage lending value in statutory or regulatory provisions. A 100% risk weight shall be assigned to the remaining part of the loan. The same principle applies to guarantees as well. As per article 113 of the Directive 2006/48/EC, asset items constituting claims carrying the explicit guarantees of central governments, central banks, international organizations,

multilateral development banks or public sector entities, where unsecured claims on the entity providing the guarantee would be assigned a 0% risk weight.

Under the IRB approach, the institutions have to estimate the PDs and sometimes also the LGD, when authorized to use the advanced IRB approach. In the case of advanced IRB approach, the LGD estimates will depend mostly on the evolution of the market value of the property. However, it is clear that the existence of collateral (assuming that the guarantee fulfills all the conditions required by relevant authorities to be accepted as an eligible form of credit risk mitigation) will imply a reduction of the LGD. The detailed procedure for the calculation of PDs and LDs can be consulted in the Directive 2006/48/EC.

D Appendix D: Loan Quantity

In this Appendix, we report the results for the impact of the EBA Capital Exercise on credit supply (as in Gropp, Mosk, Ongena and Wix, 2019) to Portuguese firms. In particular, we estimate the following equation:

$$\begin{aligned}
(L_{i,j,t} - L_{i,j,t-1}) / (0.5(L_{i,j,t} + L_{i,j,t-1})) = & \alpha + \beta * relationship\ length_{i,j,t} + \\
& \delta * relationship\ length_{i,j,t} * Treated * Post + \delta_1 * relationship\ length_{i,j,t} * Treated \\
& + \delta_2 * Treated * Post + \delta_3 * relationship\ length_{i,j,t} * Post + \gamma * f_{i,t} + \eta * b_{j,t} + \lambda_i + \mu_j + \epsilon_{i,j,t}
\end{aligned}
\tag{7}$$

The credit growth rate encompasses the growth of outstanding credit both at the intensive

and extensive margin (as in Davis and Haltiwanger, 1992, and Chodorow-Reich, 2014), and is in the interval $[-2,2]$. The results are shown in Table D1. The double interaction term $Post * Treated$ is negative in all columns: it suggests that firms borrowing from treated banks have about a 20 percentage points lower growth of outstanding credit. The triple interaction is positive and varies around 3.4 to 5.6 percentage points, indicating that firms with a one standard deviation longer relationship length see this drop muted with about 5 percentage points (standard deviation is 0.92). All in all, while making use of granular data, these results are in line with Gropp, Mosk, Ongena and Wix, (2019). Furthermore, they highlight the role of strong bank-firm relationships in mitigating credit supply shocks.

Table D1: EBA Capital Exercise: Loan Quantity. The table shows the results for Equation (7). The dependent variable is the growth of outstanding bank-firm credit, defined as change in total credit from previous to the current month from, divided by the average credit over the two periods (Davis and Haltiwanger, 1992). Column 2 has 2012Q1-2012Q2 as post period whereas all other columns have Q4 of 2011 and Q1 of 2012 as post period. Columns 3 and 4 have firm and firm-time fixed effects, respectively. Column 5 spans all firms but includes Industry-Location-Size (ILS) fixed effects. Column 6 performs a matched control group based on bank size. Column 7 includes controls for the ECB's Long-Term-Refinancing-Operations (LTRO) at the bank level. Bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. Standard errors are clustered at the bank level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Q4, Q1	Q1, Q2	Q4, Q1	Q4, Q1	All firms	Matching	LTRO
<i>RelationshipLength</i>	0.033*** [0.012]	0.033*** [0.012]	0.013*** [0.005]	0.004 [0.006]	0.027*** [0.004]	0.029*** [0.011]	0.004 [0.006]
<i>RelationshipLength * Treated</i>	-0.003 [0.009]	-0.003 [0.009]	0.003 [0.003]	0.003 [0.003]	-0.002 [0.002]	-0.012** [0.005]	0.003 [0.003]
<i>RelationshipLength * Post</i>	-0.006 [0.013]	-0.006 [0.012]	0.009 [0.007]	0.003 [0.009]	-0.010* [0.006]	-0.040** [0.017]	0.003 [0.009]
<i>RelationshipLength * Post * Treated</i>	0.048** [0.022]	0.034** [0.017]	0.047*** [0.009]	0.056*** [0.011]	0.044*** [0.007]	0.053*** [0.014]	0.056*** [0.011]
<i>Post * Treated</i>	-0.182* [0.092]	-0.121* [0.071]	-0.175*** [0.038]	-0.268*** [0.044]	-0.161*** [0.026]	-0.234*** [0.062]	-0.208*** [0.044]
Bank FE	Y	Y	Y	Y	Y	Y	Y
Firm FE	N	N	Y	N	N	N	N
Firm-time	N	N	N	Y	N	Y	Y
ILS FE	N	N	N	N	Y	N	N
R-squared	0.05	0.05	0.27	0.33	0.07	0.37	0.33
Number of obs.	310740	291951	310740	297327	367297	215230	297327

E Appendix E: Quantifying the Role of Collateral for RWA for New Loans

In this Appendix, we quantify for new corporate loans the importance of collateral in banks' reduction of risk-weighted assets (RWA) and compare it to banks' reduction in RWA stemming from cutting lending (reduction in assets following the EBA exercise has also been identified in earlier work, such as Gropp, Mosk, Ongena and Wix (2019)). As we show below, the reduction in the *risk-weighted* assets stemming from changes in collateral accounts for 45 % of the overall drop in the RWA related to new loan initiations (4.5% out of the total 10.1%).

Table E1 below illustrates the assumptions built and refers to the relevant empirical results to underpin these numbers. The different columns in the table show the pre- and post-period for the treated banks. We start from a situation where 100 new loans were issued before the event, each of size 100. Our results from the most saturated volume regression in Table D1, column 4 (other columns suggest almost the same magnitude), show a drop in new loans of about 5.6% (at log of mean relationship length $0.268 - 3.78 \cdot 0.056$), giving 94.4 loans after. The second line shows the rate of collateralization being, for simplicity, 50% of all loans before. Out of those, 24% have low risk-weight collateral (Table 1) where we assume zero risk weight, and 76% have high-risk weights where we assume an average weight of 50%. (averaged over 0.35, 0.5 and 0.6). After the event, the likelihood of collateralization

is assumed to increase by 4 percentage points, since our diff-in-diff coefficient hovers around it across the models in our main tables (Table 3 and Table 4) i.e., 54% implying that $94.4 \times 0.46 = 43.4$ loans are not collateralized leaving 50 loans that are collateralized. Of the 50 collateralized loans, the low-risk weight collateral share increases by 3 percentage points to 27% leaving 73% for high-risk weight collateral. To calculate this increase, we estimate a diff-in-diff version of Table 7 without the relationship length measure (while in the meantime, from Table 7, the mean borrower with log of relationship length of 3.78, sees an increase in low-risk collateral of 2.4%: $0.345 - 3.78 \times 0.085$, as in column 1). This leads to an overall drop in new RWA of 10.1% (i.e., $(6900 - 6203)/6900$) of which 5.6% comes from cutting lending and 4.5% from the collateral channel. Put differently, the collateral channel has a value of about 80% compared to cutting lending ($4.5/5.6$). Of course this assumes that the size and collateral dimension are uncorrelated.

Table E1: Quantifying the Role of Collateral for Changes in RWA: New Corporate Loans. The table shows the quantification of changes in collateral for changes in RWA by using some simplifying assumptions and our coefficient estimates. Note 1: From table 3, the probability of collateralization (conditional on a loan being granted) has gone up by 4 pp., hence 0.92×0.54 , or approximately 50 loans remain collateralized in the post period. Note 2: From table 7 in the paper, the probability of low risk weight collateral (conditional on collateral being pledged) for the average relationship borrower has increased by $0.345 - 0.085 \times \ln(44) = 0.03$. This is the number we use in the third column.

	Pre		Post
Assets	100*100	5.6% decline in new loan probability, assuming all loans similar.	94.4*100
RWA, taking into consideration 50 percent of collateralized loans, of which high-risk weight (with coefficients of 0.35, 0.5 or 0.6, averaged at 0.5) has proportion 0.76 and low risk weight (coefficient of 0) has proportion 0.24.	$50 \times 100 \times 1 + 50 \times 100 \times (0.24 \times 0 + 0.76 \times 0.5) = 6900$	RWA, taking into consideration 50.976 (i.e., 94.4×0.54) collateralized loans, of which low risk weight (0) with proportion $0.24 + 0.03$. There are 43.424 (i.e., 94.4×0.46) unsecured loans	$94.4 \times 0.46 \times 100 \times 1 + 94.4 \times 0.54 \times 100 \times (0.27 \times 0 + 0.73 \times 0.5) = 6203$ Without the collateral channel: $94.4 \times 0.50 \times 100 \times 1 + 94.4 \times 0.50 \times 100 \times (0.24 \times 0 + 0.76 \times 0.5) = 6513.6$ So then collateral is about 80% of the deleveraging channel

F Appendix F: Further Robustness checks

Table F1: **Collateral type: without guarantees.** The table shows the results for Equation (4). The dependent variable *low risk weight collateral* is an indicator variable taking the value of 1 if collateral type is real estate, or if it is financial collateral. The dummy takes value 0 if the loan is collateralized by other collateral. The sample only includes collateralized loans. *Treated* is a dummy equal to 1 for Portuguese banks that were affected by EBA Capital Exercise and 0 otherwise. The pre-EBA window is Q1 and Q2 of 2011. Columns 1 and 5 use Q4:2011 and Q1:2012 as the post or treatment period (i.e., Q4,Q1 as indicated on top of the column). The other columns use Q1 and Q2 of 2012 as the post or treatment period (i.e., Q1,Q2 as indicated on top of the column). Columns 1-4 (5-8) present results for equation 3. Variable definitions in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan volume*). Standard errors are clustered at the bank level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Q4,Q1	Q1,Q2	Q1,Q2	Q1,Q2	Q4,Q1	Q1,Q2	Q1,Q2	Q1,Q2
<i>RelationshipLength</i>	-0.021*** [0.001]	-0.025*** [0.001]	-0.025*** [0.002]	-0.021*** [0.002]				
<i>RelationshipLength * Treated</i>	0.068*** [0.001]	0.076*** [0.001]	0.079*** [0.001]	0.079*** [0.001]				
<i>RelationshipLength * Post</i>	0.039*** [0.003]	0.031*** [0.002]	0.021*** [0.003]	0.020*** [0.003]				
<i>RelationshipLength * Post * Treated</i>	-0.083*** [0.004]	-0.082*** [0.003]	-0.057*** [0.003]	-0.071*** [0.004]				
<i>Post * Treated</i>	0.347*** [0.016]	0.322*** [0.012]	0.215*** [0.014]	0.275*** [0.017]	0.390*** [0.013]	0.374*** [0.009]	0.265*** [0.011]	0.328*** [0.013]
<i>Cum. relationship</i>					-0.050*** [0.001]	-0.054*** [0.002]	-0.047*** [0.002]	-0.041*** [0.002]
<i>Cum. relationship * Treated</i>					0.084*** [0.001]	0.095*** [0.001]	0.098*** [0.002]	0.098*** [0.002]
<i>Cum. relationship * Post</i>					0.058*** [0.003]	0.052*** [0.003]	0.039*** [0.003]	0.038*** [0.004]
<i>Cum. relationship * Post * Treated</i>					-0.118*** [0.004]	-0.119*** [0.003]	-0.087*** [0.003]	-0.106*** [0.004]
<i>Loan volume</i>	0.023***	0.023***	0.022***	0.022***	0.023***	0.023***	0.022***	0.022***
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	N	N	Y	N	N	N	Y	N
Firm-time FE	N	N	N	Y	N	N	N	Y
R-squared	0.07	0.08	0.32	0.35	0.07	0.07	0.31	0.35
Number of obs.	335212	318704	315774	309911	335212	318704	315774	309911

Table F2: **EBA Capital Exercise and collateral type: intensity of treatment.** The table shows the results for Equation (4) where the treatment is captured by its intensity. The dependent variable *low risk weight collateral* is an indicator variable taking value of 1 if collateral type is real estate, a guarantee backed by government or a financial institution, or if it is financial collateral. The dummy takes value 0 if the loan is collateralized by other collateral. The sample only includes collateralized loans. The pre-EBA window is Q1 and Q2 of 2011. Columns 1 and 5 use Q4:2011 and Q1:2012 as the post or treatment period (i.e., Q4,Q1 on top of the column). All other columns use Q1 and Q2 of 2012 as the post or treatment period, allowing for a three month adjustment period (i.e., i.e., Q1,Q2 on top of the column). Columns 1-4 (5-8) present results for equation 3 (4). *Shortfall* : the percentage shortfall of capital (as a fraction of risk-weighted assets) for Portuguese banks that were treated by EBA Capital Exercise. Variable definitions in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan volume*). Standard errors are clustered at the bank level.

	(1) Q4,Q1	(2) Q1,Q2	(3) Q1,Q2	(4) Q1,Q2	(5) Q4,Q1	(6) Q1,Q2	(7) Q1,Q2	(8) Q1,Q2
<i>RelationshipLength</i>	-0.021*** [0.001]	-0.024*** [0.001]	-0.019*** [0.002]	-0.017*** [0.002]				
<i>RelationshipLength * Shortfall</i>	0.004*** [0.000]	0.005*** [0.000]	0.006*** [0.000]	0.007*** [0.000]				
<i>RelationshipLength * Post</i>	0.031*** [0.003]	0.024*** [0.002]	0.012*** [0.003]	0.015*** [0.003]				
<i>RelationshipLength * Post * Shortfall</i>	-0.019*** [0.001]	-0.020*** [0.001]	-0.012*** [0.001]	-0.017*** [0.001]				
<i>Post * Shortfall</i>	0.084*** [0.005]	0.081*** [0.003]	0.048*** [0.004]	0.066*** [0.005]	0.092*** [0.004]	0.089*** [0.003]	0.063*** [0.003]	0.083*** [0.004]
<i>Cum. relationship</i>					-0.045*** [0.001]	-0.048*** [0.002]	-0.037*** [0.002]	-0.033*** [0.002]
<i>Cum. relationship * Shortfall</i>					0.005*** [0.000]	0.006*** [0.000]	0.007*** [0.000]	0.008*** [0.000]
<i>Cum. relationship * Post</i>					0.041*** [0.003]	0.038*** [0.003]	0.024*** [0.003]	0.027*** [0.004]
<i>Cum. relationship * Post * Shortfall</i>					-0.027*** [0.001]	-0.027*** [0.001]	-0.019*** [0.001]	-0.026*** [0.001]
<i>Loan Volume</i>	0.023*** [0.001]	0.024*** [0.001]	0.019*** [0.001]	0.018*** [0.001]	0.023*** [0.001]	0.024*** [0.001]	0.019*** [0.001]	0.018*** [0.001]
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	N	N	Y	N	N	N	Y	N
Firm Time FE	N	N	N	Y	N	N	N	Y
R-squared	0.07	0.07	0.31	0.35	0.07	0.07	0.31	0.35
Number of obs.	335212	318704	315774	309911	335212	318704	315774	309911

Parallel trends We report the coefficients for the double and triple interaction terms. In columns 1-4, pre-EBA periods are analyzed for the *relationship length* measure. Column 1 shows the results for the window two quarters before and after mid-year 2009: *Post mid9* indicates that the *Post* variable used in that specification takes value 1 for the period after June 2009, and 0 in and before June 2009. In all specifications, both pre- and post-periods span over two quarters. Similarly, *Post9* in column 2 indicates that the time dummy used takes value 1 for the two-quarter period beginning 2010, while the pre-period in the specification is the last two quarters of 2009. In column 3(4) *Post mid10* (*Post10*) indicates that *Post* takes value of 1 from July 2010 (January 2011) over two quarters and 0 for the preceding two quarters. As the double coefficients in the table confirm, treated banks did not increase collateral requirements (if anything, they in fact somewhat decreased it). At the same time, the coefficients on the triple interaction terms confirm that there was no differential treatment for relationship borrowers by treated banks compared to the control banks. The last 4 columns use the cumulative relationship length as the relationship variable, in the same order of windows. Again, we observe that the interaction terms are not significant.

Table F3: **Falsification.** The dependent variable is *collateral dummy*. The period after which *Post* indicator takes value 1 is shown on top of the column for each specification. Each specification uses a window of 4 quarters (two quarters before and after). Columns 1 and 5 use as post-(pre-) window Q3 and Q4 (Q1 and Q2) of 2009, whereas columns 2 and 6 use Q1 and Q2 of 2010 as post-window (Q3 and Q4 of 2009 as pre-), and so on for the other columns. Columns 1-4 (5-8) use *RelationshipLength* (*Cum.relationship*) as a proxy for relationship strength. Variable definitions are in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan volume*). Standard errors are clustered at the bank level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Post mid9	Post9	Post mid10	Post10	Post mid9	Post9	Post mid10	Post10
<i>Post * Treated</i>	-0.057 [0.042]	-0.005 [0.022]	-0.037 [0.025]	0.004 [0.013]	-0.009 [0.010]	0.001 [0.007]	-0.002 [0.006]	0.002 [0.004]
<i>RelationshipLength * Post * Treated</i>	-0.000 [0.001]	-0.000 [0.000]	0.000 [0.000]	-0.000 [0.000]				
<i>Cum.relationship * Post * Treated</i>					0.010 [0.010]	0.000 [0.009]	0.004 [0.009]	0.006 [0.006]
R-squared	0.42	0.42	0.43	0.43	0.73	0.42	0.43	0.43
Number of obs.	516732	513067	492412	506724	516732	513067	492412	506724

Table F4: **EBA Capital Exercise and loan collateralization: Robustness.** The table shows the results for Equation (3). The dependent variable is the *collateral dummy*. Columns 1 and 2 include all foreign subsidiaries, while columns 3 and 4 match the control group on bank size. Column 5 uses all firms, including those with single-bank relationships. Column 6 further controls for the amount of financing received through LTRO, while column 7 restricts the sample to end of 2011 (start of LTRO). Column 8 drops all foreign (European and non-European) banks. ILS stands for industry-location-size fixed effects. Variable definitions are in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan volume*). Standard errors are clustered at the bank level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	with foreign	with foreign	matched	matched	all firms	LTRO	LTRO	no foreign
<i>RelationshipLength</i>	-0.027*** [0.001]	-0.033*** [0.002]	-0.028*** [0.003]	-0.030*** [0.004]	-0.031*** [0.001]	-0.034*** [0.002]	-0.037*** [0.002]	-0.027*** [0.002]
<i>RelationshipLength * Treated</i>	0.024*** [0.003]	0.014*** [0.003]	0.006* [0.003]	0.011*** [0.003]	0.031*** [0.002]	0.010*** [0.003]	0.003 [0.003]	0.003 [0.003]
<i>RelationshipLength * Post</i>	0.014*** [0.002]	0.015*** [0.002]	0.020*** [0.003]	0.010*** [0.003]	0.015*** [0.002]	0.017*** [0.003]	0.008*** [0.003]	0.012*** [0.003]
<i>RelationshipLength * Post * Treated</i>	-0.018*** [0.003]	-0.017*** [0.004]	-0.016*** [0.004]	-0.011*** [0.003]	-0.014*** [0.003]	-0.019*** [0.004]	-0.014*** [0.004]	-0.013*** [0.004]
<i>Post * Treated</i>	0.037*** [0.012]	0.031** [0.014]	0.020 [0.015]	0.027*** [0.010]	0.027*** [0.010]	0.040*** [0.015]	0.026** [0.014]	0.024* [0.014]
<i>Loan volume</i>	0.134*** [0.000]	0.144*** [0.000]	0.151*** [0.000]	0.151*** [0.000]	0.147*** [0.000]	0.150*** [0.000]	0.150*** [0.000]	0.154*** [0.000]
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	N	Y	N	N	N	N	N
Firm-time	N	Y	N	Y	N	Y	Y	Y
ILS FE	N	N	N	N	Y	N	N	N
R-squared	0.40	0.59	0.61	0.63	0.44	0.60	0.59	0.62
Number of obs.	541711	536549	391643	384547	645099	492929	298455	449742

Table F5: **EBA Capital Exercise and collateral type: Robustness.** The table shows the results for Equation (4). Sample covers all loans that are collateralized. The dependent variable is the *low risk weight collateral* dummy. Columns 1 and 2 drop all foreign subsidiaries, while columns 3 and 4 keep only large banks in the control group. Column 5 uses all firms, including those with single-bank relationships. Column 6 further controls for the amount financing received through LTRO, while column 7 restricts the sample to end of 2011 (start of LTRO). ILS stands for industry-location-size fixed effects. Variable definitions are in Appendix B. Time dummies, bank controls (size, capital ratio, liquidity ratio) and firm controls (size, age, profitability and sector of operation at two digit NACE code level) are included in all specifications, but not reported for brevity. We also control for the size of the loan (*Loan volume*). Standard errors are clustered at the bank level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	with foreign	with foreign	matched	matched	all firms	LTRO	LTRO	no foreign
<i>RelationshipLength</i>	-0.012*** [0.001]	-0.020*** [0.002]	-0.012*** [0.001]	-0.011*** [0.001]	-0.040*** [0.001]	-0.027*** [0.002]	-0.025*** [0.002]	-0.042*** [0.003]
<i>RelationshipLength * Treated</i>	0.024*** [0.001]	0.027*** [0.002]	0.013*** [0.002]	0.012*** [0.002]	0.055*** [0.001]	0.060*** [0.001]	0.053*** [0.002]	0.058*** [0.002]
<i>RelationshipLength * Post</i>	0.038*** [0.003]	0.028*** [0.003]	0.011*** [0.002]	0.010*** [0.002]	0.043*** [0.002]	0.024*** [0.004]	0.035*** [0.005]	0.046*** [0.005]
<i>RelationshipLength * Post * Treated</i>	-0.079*** [0.003]	-0.063*** [0.005]	-0.045*** [0.003]	-0.049*** [0.006]	-0.098*** [0.003]	-0.073*** [0.005]	-0.083*** [0.007]	-0.086*** [0.005]
<i>Post * Treated</i>	0.309*** [0.013]	0.239*** [0.018]	0.184*** [0.014]	0.216*** [0.022]	0.382*** [0.011]	0.273*** [0.018]	0.299*** [0.026]	0.333*** [0.021]
<i>Loan volume</i>	0.026*** [0.001]	0.020*** [0.001]	0.012*** [0.001]	0.012*** [0.001]	0.025*** [0.000]	0.018*** [0.001]	0.020*** [0.001]	0.016*** [0.001]
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	N	Y	N	N	N	N	N
Firm-time	N	Y	N	Y	N	Y	Y	Y
ILS FE	N	N	N	N	Y	N	N	N
R-squared	0.31	0.35	0.33	0.36	0.10	0.35	0.36	0.36
Number of obs.	329563	320608	245836	236563	406867	309911	196155	279376

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