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Bank response to higher capital requirements: Evidence from a quasi-natural experiment

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Bank Response To Higher Capital Requirements: Evidence From A Quasi-Natural Experiment

SAFE Working Paper No. 156

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Non-Technical Summary

This paper studies the impact of higher capital requirements on banks' balance sheets and its transmission to the real economy. Basel III, which will become fully effective in 2019, significantly increases capital requirements for banks. However, at this point, the economic implications of such higher capital requirements are still unclear. Banks can, in principle, increase their regulatory capital ratios in two different ways: they can either increase their levels of regulatory capital (the numerator of the capital ratio) or they can shrink their risk-weighted assets (the denominator of the capital ratio). While raising capital is generally considered "good deleveraging" by regulators, shrinking assets has potentially adverse effects on the supply of credit to the real economy if many banks simultaneously engage in cutting lending. How banks adjust their balance sheets in response to higher capital requirements is thus an empirical question of crucial importance for understanding the real implications of the higher capital requirements recently imposed under Basel III.

The most important challenge in studying the effect of capital requirements is to find exogenous variation in capital requirements. Yet, capital requirements tend to vary little over time, and when they do change, they change for all banks in a given economic area at the same time, leaving no cross-sectional variation to exploit. We address these empirical challenges by exploiting the 2011 capital exercise, conducted by the European Banking Authority (EBA), as a quasi-natural experiment. The capital exercise required a subset of European banks to reach and maintain a 9% core tier 1 capital ratio by the end of June 2012. We exploit the country-specific selection rule of the EBA capital exercise, based on bank size, and compare EBA banks, subject to the higher capital requirements (i.e., our treatment group) with similar, other European banks not subject to higher capital requirements (i.e. our control group).

The main findings of our paper are as follows. First, we document that EBA banks raised their regulatory capital ratios by 1.9 percentage points compared to banks not subject to the higher capital requirements. EBA banks achieved this by reducing their levels of risk-weighted assets by 16 percentage points rather than by increasing their levels of capital relative to the matched control group. We show that this reduction in total assets can mainly be attributed to a reduction in outstanding customer loans. This finding, however, is not sufficient to conclude that the supply of credit by EBA banks contracted, since it might very well just reflect a reduction in credit demand by firms borrowing from EBA banks. In order to disentangle credit supply from credit demand, we use syndicated loan data and find that EBA banks reduced their credit supply of syndicated loans by 27 percentage points relative to banks in the control group.

Ultimately, the degree to which a reduction in credit supply from EBA banks implies real effects at the firm level depends on the extent to which other banks, not subject to higher capital requirements, "pick up the slack". Hence, we investigate how EBA banks' reduction in lending due to the increase in capital requirements affects the growth of firms which obtain a larger share of their bank credit from EBA banks. We find that firms with a high EBA borrowing share exhibited 4 percentage points less asset growth, 6 percentage points less investment growth, and 5 percentage points less sales growth than firms less reliant on funding from EBA banks.

An important policy implication of our paper is that capital requirements which target the regulatory capital ratio have potentially adverse effects on the real economy. As suggested by Hanson, Kashyap, and Stein (2011), targeting the absolute amount of new capital that has to be raised instead of the capital ratio could mitigate this problem, an approach which has been successfully applied in the U.S. stress tests conducted in 2009. In this context, our paper highlights the risks associated with capital regulation that focuses on capital ratios as the policy target variable while leaving it to the discretion of banks how to increase their capital ratios.

Bank Response To Higher Capital Requirements: Evidence From A Quasi-Natural Experiment

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Bank Response To Higher Capital Requirements: Evidence From A Quasi-Natural Experiment

ABSTRACT

We study the impact of higher capital requirements on banks' balance sheets and its transmission to the real economy. The 2011 EBA capital exercise is an almost ideal quasi-natural experiment to identify this impact with a difference-in-differences matching estimator. We find that treated banks increase their capital ratios by reducing their risk-weighted assets and - consistent with debt overhang - not by raising their levels of equity. Banks reduce lending to corporate and retail customers, resulting in lower asset-, investment- and sales growth for firms obtaining a larger share of their bank credit from the treated banks.

Basel III, which will become fully effective in 2019, significantly increases capital requirements for banks. However, at this point, the economic implications of such higher capital requirements are still unclear. Banks can, in principle, increase their regulatory capital ratios in two different ways: they can either increase their levels of regulatory capital (the numerator of the capital ratio) or they can shrink their risk-weighted assets (the denominator of the capital ratio) (Admati, DeMarzo, Hellwig, and Pfleiderer, 2017). While raising capital is generally considered "good deleveraging" by regulators, shrinking assets has potentially adverse effects if many banks simultaneously engage in cutting lending (Hanson, Kashyap, and Stein, 2011). How banks adjust their balance sheets in response to higher capital requirements is thus an empirical question of crucial importance to understand the real implications of higher capital requirements.

The empirical identification of the effect of higher capital requirements on banks' behavior faces a number of challenges. The most important challenge is to find exogenous variation in capital requirements. Yet, capital requirements tend to vary little over time, and when they do change, they change for all banks in a given economic area at the same time, leaving no cross-sectional variation to exploit. In the case when supervisors make use of discretion and impose bank-specific requirements, they will be correlated with (unobserved) bank characteristics and thus not be exogenous with regard to banks' balance sheets. Finally, in order to assess the effects of capital requirements on bank lending, one needs to disentangle credit supply from credit demand.

We address these empirical challenges by exploiting the 2011 capital exercise, conducted by the European Banking Authority (EBA), as a quasi-natural experiment. The capital exercise required a subset of European banks to reach and maintain a 9% core tier 1 capital ratio by the end of June 2012.[1] The institutional features of the capital exercise are particularly well-suited to address the above mentioned empirical challenges. First, the required core tier 1 ratio of 9% constituted an economically significant increase in capital requirements compared to the previously required 5%.[2] Second, the rule by which banks were selected into the capital exercise allows us to disentangle

[1]The core tier 1 ratio is defined as a bank's core tier 1 capital over a bank's risk-weighted assets, with core tier 1 capital comprising only the highest quality capital instruments (common equity), disclosed reserves and hybrid instruments provided by governments (EBA, 2011c).

[2]Two regulatory interventions by the EBA increased the capital requirements for EBA banks in 2011: the 2011 EBA stress test required a 5% core tier 1 ratio, and the 2011 EBA capital exercise subsequently raised the required core tier 1 ratio to 9%. The estimated 115 billion euro capital shortfall due to the EBA capital exercise was however well above the 2.5 billion euro capital shortfall due to the 2011 EBA stress test (Acharya, Engle, and Pierret, 2014). As we argue in Section I, we therefore focus on the 2011 EBA capital exercise as the main shock to banks' capital requirements.

the effect of capital requirements from effects associated with bank size. The EBA used a country-specific selection rule and included banks "in descending order of their market shares by total assets in each Member State" such that the exercise covered "50% of the national banking sectors in each EU Member State" (EBA, 2011a).[3] Since national banking sectors in Europe differ with regard to their total size, this country-specific selection threshold yielded a considerable overlap in size between banks selected and not selected into the exercise. Moreover, the explicit selection rule based on bank size implies that selection into the capital exercise was based on observable bank characteristics. We exploit this exogenous variation in the bank selection rule and employ a difference-in-differences matching estimation approach to examine how banks subject to higher capital requirements adjust their balance sheets compared to otherwise similar banks not subject to a change in capital requirements.

Our main findings are as follows. First, we document that Capital Exercise banks (our treatment group) raised their core tier 1 capital ratios by 1.9 percentage points more compared to banks not subject to the higher capital requirements (the control group). Capital Exercise banks achieved this by reducing their levels of risk-weighted assets (RWA) by 16 percentage points. The control group is crucial for uncovering this finding: Capital Exercise banks increased their levels of core tier 1 capital by 19% over our sample period, but the control group raised their levels of core tier 1 capital by the same magnitude.

We then study the effects of higher capital requirements on banks' balance sheet composition. Risk-weighted assets for credit risk - the most important component of RWA - are calculated by multiplying each of a bank's exposures with asset class specific risk weights (BIS, 2005).[4] As a result, some asset classes require less bank capital than others. A sudden increase in capital requirements could therefore change the capital allocation of banks from "capital intensive" to "capital light" activities (which require less regulatory capital). To study the effect of the capital exercise on the composition of banks' balance sheets, we hand-collect information about banks' exposures to different asset classes from the banks' Pillar 3 disclosure reports. We find that treated

[3]The EBA used the same selection procedure as in the EBA stress test in June 2011. Selection was based on total consolidated assets as of end of 2010 and therefore not based on bank-specific events in the months prior to the capital exercise.

[4]Basel II categorizes banks' exposures into five broad asset classes (corporate, sovereign, bank, retail, and equity) and distinguishes between two methodologies for calculating risk-weighted assets: The Standardised Approach (SA) based on standardized risk weights, and the Internal Ratings-Based (IRB) approach based on banks' own internal risk estimates, which have to follow asset class specific rules for the calculation of risk weights.

banks mainly reduced their exposures to corporate and retail borrowers. In further tests, we show that Capital Exercise banks reduced their risk-weighted assets relative to the control group by engaging in asset shrinking rather than risk reduction.

These results suggest that banks are reluctant to issue new equity to increase their capital ratios when required to do so by regulators. Potential explanations include asymmetric information and debt overhang. Admati, DeMarzo, Hellwig, and Pfleiderer (2017) show that, in particular, banks with a large amount of outstanding subordinated debt should prefer asset sales to new equity issuances in the face of higher capital requirements. In line with this prediction, we show that Capital Exercise banks with an above median amount of subordinated debt are more likely to shrink their assets and retire subordinated debt.[5]

Finally, we study whether the reduction in lending by Capital Exercise banks had real effects on firms. Simply observing a reduction in outstanding customer loans on banks' balance sheets is not sufficient to conclude that the supply of credit by Capital Exercise banks contracted, since this might very well just reflect a reduction in credit demand by firms borrowing from Capital Exercise banks. Moreover, even if we observe a contraction in credit by Capital Exercise banks, other competing banks may have picked up the slack, resulting in no adverse real effects. In order to disentangle credit supply from credit demand, we use syndicated loan data and exploit the presence of multiple bank-firm relationships to control for credit demand. Specifically, we employ a modified version of the Khwaja and Mian (2008) estimator, which estimates the change in outstanding syndicated loans of a bank to country-industry firm clusters. We show that Capital Exercise banks reduced their credit supply of syndicated loans by 17 percentage points relative to banks in the control group. Further, we find that firms with an initial high share of loans from Capital Exercise banks exhibited 4 percentage points lower asset growth, 6 percentage points lower investment growth, and 5 percentage points lower sales growth than firms less reliant on funding from Capital Exercise banks. This result is driven by unlisted firms which are less likely to substitute a credit reduction with other sources of funding.

A number of falsification tests suggest that our results are not confounded by other factors. To rule out that the results are driven by Capital Exercise banks' exposure to the European sovereign

[5]Vallée (2016) documents that numerous European banks bought back subordinated hybrid bonds trading under par value to strengthen their capitalizations. These "liability management exercises" are in line with the predictions of Admati, DeMarzo, Hellwig, and Pfleiderer (2017) and our findings that these banks reduced their credit supply.

debt crisis, we conduct a placebo test around the start of the crisis in 2010 and show that Capital Exercise banks and banks in the matched control group exhibited a similar evolution in their levels of core tier 1 capital and risk-weighted assets during this placebo period.[6] Other contaminating events, such as moral suasion by governments or the ECB's longer-term refinancing operations (LTRO), could provide alternative explanations for our results. Banks in Greece, Ireland, Italy, Portugal, and Spain (GIIPS countries) increased their exposures to domestic sovereign debt (see e.g. Ongena, Popov, and Van Horen (2016)) and made use of the ECB's LTRO program (Van Rixtel and Gasperini, 2013). We therefore test whether our results are driven by banks from these countries, but we do not find evidence for this alternative hypothesis. Importantly, this suggests that the results are not driven by the European debt crisis, but also have validity in situations where banks are not under any particular stress (as in northern Europe during our sample period).

Our paper is most closely related to the literature examining the effect of shocks to banks' capital on bank lending. Peek and Rosengren (1997) exploit an exogenous shock to bank capital without a change in capital requirements to indirectly infer the effect on lending when capital requirements become binding. Another strand of literature seeks to directly exploit changes in capital requirements. An early study by Berger and Udell (1994) investigates bank lending before and after the introduction of Basel II, but without the benefit of exogenous cross-sectional variation in capital requirements. To alleviate this concern, Kashyap, Stein, and Hanson (2010) adopt a model-based calibration approach for the U.S., Fraisse, Lé, and Thesmar (2015) exploit variation in capital requirements across banks in France due to the use of internal risk models, Aiyar, Calomiris, Hooley, Korniyenko, and Wieladek (2014) study the impact of changes to U.K. bank-specific capital requirements on cross-border bank loan supply, Jimenéz, Ongena, Peydró, and Saurina (2016) analyze the introduction and later modifications in dynamic provisioning requirements in Spain, and Kisin and Manela (2016) estimate the shadow cost of capital requirements by exploiting a costly loophole that allowed banks in the U.S. to relax these constraints. More recently, Célérier, Kick, and Ongena (2016) explore the impact on lending in Germany by banks affected by tax reforms in Italy (in 2000) and Belgium (in 2006) which decreased their cost of bank equity and Jensen (2015) and De Marco and Wieladek (2015) exploit changes in bank specific capital requirements

[6] Popov and Van Horen (2015) show that banks with risky sovereign exposures already reduced their lending in 2010, one year prior to the capital exercise.

in Denmark and the UK respectively. Finally, Mésonnier and Monks (2015) also exploit the EBA capital exercise and find that this regulatory event induced a credit crunch in the Euro Area.

We contribute to this literature in several ways. First, while most papers in the literature (with the exception of Mésonnier and Monks (2015)) study single-country settings, we exploit the country-specific bank selection rule of the 2011 EBA capital exercise to uniquely identify the effects of higher capital requirements across 18 countries. Second, our paper does not exclusively focus on lending, but investigates in detail how banks adjust both the asset- and liability side of their balance sheets in response to an increase in capital requirements. Third, we examine *why* banks are reluctant to issue equity. We provide novel empirical evidence for the recent theoretical prediction by Admati, DeMarzo, Hellwig, and Pfleiderer (2017) that banks' existing shareholders prefer to increase capital ratios by reducing assets rather than by raising new capital if banks can repurchase subordinated debt. Finally, we study the transmission of banks' balance sheet adjustments to the real economy in a multi-country setting and assess the resulting real effects on firms across Europe.

I. The 2011 EBA Capital Exercise

This section describes the objective and institutional details of the EBA capital exercise, which was announced by the EBA on October 26, 2011 (see Figure 1). The objective of the exercise was to restore confidence in the EU banking sector by ensuring that banks had sufficient capital to insure against unexpected losses. To achieve this objective, the EBA required 61 banks to build up additional capital buffers to reach a 9% core tier 1 ratio by the end of June 2012. The capital exercise was an official "Recommendation" issued by the EBA. According to article 16(3) of the EBA regulation as established by the European Parliament, national supervisory authorities must make every effort to comply with the "Recommendation". The EBA capital exercise did not coincide with other changes in capital requirements for European banks. In particular, the EU only started with the gradual introduction of Basel III in 2013 (Capital Requirements Directive IV). After the capital exercise, the EBA kept monitoring banks' compliance with the 9% core tier 1 ratio.

[Figure 1 about here]

Both the timing and magnitude of this increase in capital requirements was unexpected. The capital exercise came only a few months after the EBA stress test in June 2011 and was described as a "quick-fire regulatory health check".[7] The *Financial Times* reported that the 9% requirement was "well beyond the current expectations of banks and analysts."[8] The credibility and rigor of the June stress test had been criticized, in particular because the Belgian bank Dexia was declared in the stress test to be one of the safest banks in Europe, but had failed less than three months later (Greenlaw, Kashyap, Schoenholtz, and Shin, 2012). Although both the EBA stress test and the subsequent EBA capital exercise increased capital requirements for Capital Exercise banks in 2011, the estimated 115 billion euro capital shortfall due to the capital exercise dwarfed the 2.5 billion euro capital shortfall due to the stress test (Acharya, Engle, and Pierret, 2014). Thus, we naturally focus on the EBA capital exercise as the singularly overriding regulatory intervention.

The 61 Capital Exercise banks were selected based on total assets. In each country, the EBA included "banks in descending order of their market shares by total assets", such that the exercise covered "at least 50% of the national banking sectors in each EU Member State in terms of total consolidated assets as of end of 2010" (EBA, 2011a).[9] For example, consider a country with Banks A, B, and C with 41, 30, and 10 billion euro in total assets respectively. The total size of this banking sector is 81 billion euro, with Bank A covering more than 50% of the banking sector in terms of total assets. In this example, the EBA would have included only Bank A in the exercise. As in the 2011 EBA stress test, selection into the capital exercise was based on total assets as of end of 2010 and selection was therefore not based on bank-specific events in the months prior to the capital exercise.

Capital Exercise banks were asked to submit their recapitalization plans to their respective national authorities outlining how they intended to reach the set targets. The EBA recommended that "banks should first use private sources of funding to strengthen their capital position to meet the required target, including retained earnings, reduced bonus payments, new issuances of

[7] "Exclusive: Europe hits banks with tougher capital test", by Philipp Halstrick and Andreas Framke, *Reuters*, October 11, 2011.

[8] "Europes banks face 9% capital rule", by Patrick Jenkins, Ralph Atkins, and Peter Spiegel, *Financial Times*, October 11, 2011

[9] From the initial 71 banks, the EBA excluded during the capital exercise banks which were "undergoing a deep restructuring", namely Dexia, Österreichische Volksbank AG, West LB, all six Greek banks (EFG Eurobank Ergasias S.A., National Bank of Greece, Alpha Bank, Piraeus Bank Group, Agricultural Bank of Greece (ATE bank), TT Hellenic Postbank S.A.) and Bankia. We do not include these banks in the analysis.

common equity and suitably strong contingent capital, and other liability management measures." The EBA also stressed that "reductions in risk-weighted assets due to the validation [...] should not, in general, be allowed as a means of addressing a capital shortfall unless these changes are already planned and under consideration by the competent authority" (EBA, 2011b). However, the EBA also left discretion to the banks which measures to take in order to comply with the higher capital requirements.[10] In addition, the EBA did not specify how they would enforce their recommendations how to recapitalize.

II. Empirical Strategy and Data

This paper exploits the 2011 EBA capital exercise to identify how banks adjust their balance sheets in response to higher capital requirements and how this adjustment process affects firms which obtain a substantial share of their borrowing from these banks. Hence, we first analyze at the bank level the extent to which the exercise changed bank behavior, in particular outstanding loan volumes of different loan portfolios. Next, we move to the individual loan level in order to disentangle credit supply from credit demand. Finally, we examine the effect of higher bank capital requirements on asset-, investment-, and sales growth at the firm level.

A. Bank-Level Analysis

The setup of the capital exercise, whereby the EBA reviewed a subset of banks' actual capital positions and sovereign exposures and "requested them (i.e., our treatment group) to set aside additional capital buffers" (EBA, 2011c), while leaving requirements unchanged for other European banks (i.e., our pool of control group banks), naturally lends itself to a difference-in-differences research design. However, selection into the capital exercise was not random. Instead, the EBA selected banks according to an explicit selection rule based on bank size, resulting in Capital Exercise banks being on average larger than Non-Capital Exercise banks. This would compromise any causal inference if large banks would differ from small banks, for example in terms of business

[10] For example: "National supervisory authorities may, following consultation with the EBA, agree to the partial achievement of the target by the sales of selected assets that do not lead to a reduced flow of lending to the EUs real economy but simply to a transfer of contracts or business units to a third party" (EBA, 2011b). In contrast, the 2009 US Supervisory Capital Assessment Program (SCAP) strictly required banks to raise additional capital, either in public markets or by issuing mandatory convertible preferred securities" (Hirtle, Schuermann, and Stiroh, 2009).

models or funding strategies, and would exhibit different trends even in the absence of a change in capital requirements.

We exploit the country-specific selection threshold of the EBA selection rule to address this potential selection problem. Figure 2 shows the size distribution of Capital Exercise banks and Non-Capital Exercise banks across different countries. While Capital Exercise banks are on average larger than Non-Capital Exercise banks, the country-specific selection threshold yields a considerable size overlap between banks selected and not selected into the capital exercise. For example, while the smallest bank included in the EBA capital exercise, the Slovenian bank Nova Kreditna banka Maribor, had 6 billion euro in total assets as of end of 2010, the largest European bank not included in the capital exercise, the French bank Crédit Mutuel, had 591 billion euro in total assets in the same year. Knowledge about the selection rule based on observable characteristics (total assets) in combination with an overlap in size allows us to combine the difference-in-differences framework with an appropriate matching methodology by matching banks from the treatment group to similar banks from the pool of control group banks.

[Figure 2 about here]

The paper uses the bias-corrected Abadie and Imbens (2002) matching estimator, which has recently been used by Almeida, Campello, Laranjeira, and Weisbenner (2011), Campello and Giambona (2013) and Kahle and Stulz (2013) in a corporate finance setting.[11] To alleviate concerns that our results are driven by bank characteristics other than size, this paper also matches on pre-treatment levels of the core tier 1 ratio, customer loans as a share of total assets, net interest income as a share of total operating revenue, depository funding as a share of total assets, and net income over total assets. These matching covariates capture potential differences in the capital structure, business models, funding strategies, and profitability of similarly sized banks prior to the capital exercise.

We adopt four different matching strategies. The *full sample matching* strategy matches four

[11] Figure 2 shows that while the distributions of total assets of Capital Exercise and Non-Capital Exercise banks overlap, they are significantly different. If the covariate distributions differ substantially, conventional regression methods can be sensitive to minor specification changes because of their heavy reliance on extrapolation of regions where there is no support in the data (Imbens, 2014). One approach to address this problem is the procedure developed by Abadie and Imbens (2002). After matching, some of the remaining bias is removed through regression on a subset of continuous covariates. We replicated the results of the bank-level part of the paper using a regression based DID approach. We report the results of this approach in Table A4 in the Online Appendix.

Non-Capital Exercise banks to each Capital Exercise bank based on the six matching covariates using the full sample of 48 Capital Exercise banks and 144 Non-Capital Exercise banks.[12] Second, we match Capital Exercise banks to Non-Capital Exercise banks in the "overlap sample" of banks which are larger than the smallest Capital Exercise bank and smaller than the largest Non-Capital Exercise bank. The purpose of this *overlap matching* strategy is to completely remove the remaining size difference between Capital Exercise banks and Non-Capital Exercise banks and to rule out that our results are driven by bank size. Third, we match Capital Exercise banks to Non-Capital Exercise banks around the selection threshold within the same country. Therefore, we construct a "threshold sample" which includes the two smallest Capital Exercise banks and the two largest Non-Capital Exercise banks within each country. The purpose of this *within country matching* strategy is to address concerns that our results are driven by cross-country differences, such as regulatory interventions and different business cycles. Finally, we use the "threshold sample" and match Capital Exercise banks to Non-Capital Exercise banks around the selection threshold within the same region (GIIPS countries and Non-GIIPS countries). This *within region matching* strategy addresses the concern that our results are driven by the European sovereign debt crisis, which mainly affected banks in GIIPS countries (Acharya, Eisert, Eufinger, and Hirsch, 2016). Table I provides an overview of our four matching strategies.

[Table I about here]

For all four matching strategies, we estimate the average treatment effect on the treated (ATT) using the bias-corrected Abadie and Imbens (2002) matching estimator. The main outcome variables of interest in the bank-level part of the paper are the change in the core tier 1 ratios, the change in the logarithms of core tier 1 capital and risk-weighted assets (the components of the capital ratio), and the change in the logarithms of outstanding customer loans.

For the bank-level part of the paper, we use annual bank balance sheet data from the SNL Financial Company database. Our initial sample contains all 61 Capital Exercise banks and all 494 Non-Capital Exercise European commercial and savings banks from the SNL Financial universe. Since the EBA capital exercise was conducted at the highest level of consolidation, we exclude

[12] Regarding the number of matches, in our baseline specification we follow Abadie and Imbens (2011) and choose four matches, which was found to be a good trade-off between the bias (which is increasing in the number of matches) and the variance (decreasing in the number of matches) of the matching estimator.

all subsidiaries of Capital Exercise banks, Non-Capital Exercise banks, and foreign banks. As the paper wants to track the behavior of independent banks over time, we also exclude all banks which were acquired during the sample period, all banks which received capital injections during the pre-treatment period and all banks with negative levels of equity. This sample construction procedure finally leaves us with a sample of 48 Capital Exercise banks and 144 Non-Capital Exercise banks. Table A1 lists all Capital Exercise banks in our sample.[13] The sample period spans two post-treatment years after the capital exercise (2012 and 2013) and a symmetrical time window of two pre-treatment years prior to the capital exercise (2009 and 2010).

In order to investigate how higher capital requirements affect the composition of banks' lending portfolios, we hand-collect the components of credit risk-weighted assets from the banks' Pillar 3 disclosure reports for the years 2009, 2010, 2012 and 2013 from the banks' websites. The third pillar of the Basel Accords is a set of disclosure requirements which allows market participants to gauge the capital adequacy of an institution.[14] We use this Pillar 3 data to investigate for which exposure classes (corporate, retail, sovereign) banks adjust their credit risk-weighted assets. Panel A of Table II provides the summary statistics of all dependent variables used in the bank-level part for the full sample.

[Table II about here]

B. Loan-Level Analysis

While bank balance sheet data is appropriate for investigating how banks adjust their balance sheets in response to higher capital requirements, it is not suitable for identifying the effect on bank lending. In particular, by using bank balance sheet data one cannot disentangle credit supply from credit demand. Thus, to study the effect of higher capital requirements on banks' credit supply, we use loan-level data on syndicated loans and, for identification, exploit multiple bank-firm relationships in the spirit of Khwaja and Mian (2008). As syndicated loans often have long maturities, bank exposures to individual firms are therefore often constant over time. We thus

[13] In Section III, we discuss that the exclusion of 13 Capital Exercise banks does not drive our results, and that we find similar results when using the full sample of 61 Capital Exercise banks.

[14] The Pillar 3 requirements mandate institutions to disclose details on the scope of application, capital, risk exposures, risk assessment processes, and the capital adequacy of the institution on an annual and quarterly basis using standard formats (BIS, 2015).

modify the estimator similar to Popov and Van Horen (2015) and Acharya, Eisert, Eufinger, and Hirsch (2016) and aggregate firms into clusters based on their industry and country of incorporation. By clustering at the country-industry level, we ensure that firms are subject to the same regional and sectoral shocks over time and we attribute the remaining variation in loan exposure volumes to a reduction in credit supply.

We then estimate the following difference-in-differences regression specification:

$$\Delta\text{Log Loan Exposure}_{bij} = \beta \cdot \text{CEB}_{bi} + \gamma \cdot X_{bi} + \eta_j + \eta_i + \epsilon_{bij} \tag{1}$$

where $\Delta Log\ Loan\ Exposure_{bij}$ is the change in loan exposures of bank b in country i to firm cluster j between the four quarters before the EBA capital exercise (2010Q3 - 2011Q2) and the four quarters after the capital exercise (2012Q3 - 2013Q2). The variable CEB_{bi} takes on the value of 1 if the bank is a Capital Exercise bank, and 0 otherwise. In addition, the specification includes bank characteristics as of 2010 (log total assets, core tier 1 ratio, customer loans as a share of total assets, net interest income as a share of total operating revenue, depository funding as a share of total assets, and net income over total assets) and firm-cluster fixed effects η_j, which absorb all cluster-specific credit demand shocks. Moreover, we include fixed effects for banks' home countries, η_i, to absorb country-specific shocks, which affect all banks in a given country. Like Khwaja and Mian (2008), we follow Bertrand, Duflo, and Mullainathan (2004) and collapse our data into a single pre- and a single post-treatment period before differencing in order to produce standard errors that are robust to concerns of autocorrelation. In addition, standard errors are clustered at the bank level.

For the loan-level part of the paper, we obtain data from Thomson Reuters LPC's Dealscan database, which contains detailed information on syndicated loan contract terms, loan types, and maturities. We collect data on all outstanding term loans and credit lines from banks in our sample to non-financial corporate borrowers incorporated in EBA countries.[15] Of the 76 banks in our matched control group, 63 were active in the syndicated loan market during our sample period and are feasible to serve as control group banks in the loan-level part of the paper. Dealscan contains full information on the loan allocation between syndicate members for about 32% of all

[15]For term loans and credit lines, we follow the variable definition of Berg, Saunders, and Steffen (2016). Table A8 in the Online Appendix reports results for Credit Line and Term Loan exposures separately.

loans. For the remaining 68%, we follow De Haas and Van Horen (2012) and divide the loan facility equally among all members of a syndicate. Our initial sample contains 10,829 syndicated loans from 109 banks to 5,693 companies. The LPC Dealscan database contains the issuance of new syndicated loans at the time of origination. In order to employ our modified version of the Khwaja and Mian (2008) estimator, we transform the data and calculate the outstanding exposure of bank b in country i to firm cluster j in quarter q using the maturity variable contained in the database. In our main analysis, we focus on the intensive margin sample which includes only country-industry firm clusters to which Capital Exercise banks lend both before and after the capital exercise. Thus, this sample excludes country-industry firm clusters that entirely stop borrowing after or do not borrow prior to the capital exercise. The intensive margin sample includes 45 Capital Exercise banks and 27 Non-Capital Exercise banks. In Section IV, we provide additional results on the extensive margin sample of firms. Panel B of Table II provides the summary statistics of all dependent variables used in the loan-level part for the full sample.

C. Firm-Level Analysis

In the final empirical step, we link the Capital Exercise banks' balance sheet adjustments to real outcomes at the firm level. A reduction in credit supply of Capital Exercise banks would not necessarily yield effects at the firm level if other banks, not subject to an increase in capital requirements, would pick up the slack. An increase in capital requirements for the subset of Capital Exercise banks would then not affect the total supply of credit to the real economy and would not affect firms' corporate policies.

In order to measure a firm j's dependence on credit supply from Capital Exercise banks (CEB) prior to the capital exercise, we construct the variable *CEB Borrowing Share*:

$$\text{CEB Borrowing Share}_j = \frac{\sum_{i[CEB]} \frac{1}{5} \sum_{q=2010Q3}^{2011Q2} OutstandingLoans_{ijq}}{\sum_{i[AllBanks]} \frac{1}{5} \sum_{q=2010Q3}^{2011Q2} OutstandingLoans_{ijq}} \tag{2}$$

where the numerator is the average amount of outstanding loans of firm j obtained from Capital Exercise banks over the four quarters prior to the capital exercise (2010Q3 - 2011Q2) and the denominator is the average amount of total outstanding loans of firm j obtained from all banks over the same period. For firms in our sample which were not borrowing in the syndicated loan

market in the period before the capital exercise (but in the period after the capital exercise), we assign a CEB borrowing share of zero, since those firms were not dependent on credit from Capital Exercise banks prior to the capital exercise. In the bank- and loan-level part, we restrict our analysis to banks from EBA countries. Since European firms might also borrow from banks incorporated in Non-European countries, we now also include those banks when computing the CEB borrowing share. We then divide our sample of firms into "Capital Exercise bank (CEB) dependent firms" with an above median dependence on credit supply from Capital Exercise banks as measured by the CEB borrowing share (our treatment group), and "Non-CEB dependent firms" with a below median dependence on credit supply from Capital Exercise banks (our control group pool). Since CEB dependent firms might differ from Non-CEB dependent firms along a number of important characteristics, we employ a difference-in-differences matching methodology analog to the one used in the bank-level part. We match firms on country of incorporation, industry as defined by the 1-digit SIC code, whether the firm is publicly listed or not, and pre-treatment levels of the logarithm of total assets, tangibility, cash flow over total assets, net worth, EBITDA over total assets, and leverage.[16]

As in the bank-level part of the paper, we estimate the treatment effect on the treated (ATT) using the Abadie and Imbens (2002) bias-corrected matching estimator.[17] The main outcome variables are the change in the logarithms of total assets, fixed assets (as a measure of investment, following Campello and Larrain (2016)), and sales between the period before the capital exercise (2009 and 2010) and after the capital exercise (2012 and 2013). All variables are winsorized at the 5% level.[18] As we expect results to be stronger for firms which are less likely to substitute a reduction in credit supply with other sources of funding (e.g., issuing equity), we also split our sample into listed and unlisted firms and report results separately.

For the firm-level part of the paper, we use information on firms' balance sheets and profit and loss statements from Bureau van Dijk's Amadeus Financials database. The database additionally contains information on a firm's country of incorporation, its SIC industry code, and whether the firm is publicly listed. We have access to the sample of firms classified as Very Large, Large, and

[16]The definitions of all variables are summarized in Table A2 in the Online Appendix.

[17]Table A10 in the Online Appendix additionally reports results of a difference-in-differences regression analysis.

[18]Regarding the level of winsorization we follow Acharya, Eisert, Eufinger, and Hirsch (2016). In unreported robustness tests, we find similar results when winsorizing the variables at the 1% level.

Medium-Sized by Amadeus. Since the Dealscan database and the Amadeus database share no common identifier, we hand-merge the two datasets and additionally require non-missing values on all relevant variables, which leaves us with a sample of 1,958 firms. Panel C of Table II provides the summary statistics of all dependent variables used in the firm level part for the full sample.

III. Results

In this section, we present the empirical results for the bank-level-, loan-level-, and firm-level part of the paper.

A. Bank-Level Results

A.1. Summary Statistics

We first provide summary statistics before and after matching using the different matching strategies. Table III shows the pre-treatment mean values of the matching covariates for Capital Exercise banks, Non-Capital Exercise banks, and control group banks as of end of 2010, the year immediately prior to the capital exercise. The paper uses the Student's t-test statistic to test for differences in means between the groups.

[Table III about here]

Panel A of Table III compares the 48 Capital Exercise banks with 144 Non-Capital Exercise banks in the unmatched sample. As expected, Capital Exercise banks significantly differ from Non-Capital Exercise banks along a number of important dimensions. Due to the capital exercise being carried out on the largest banks in each country, the mean Capital Exercise bank is more than 18 times larger than the mean Non-Capital Exercise bank. The two groups of banks also significantly differ in terms of their business models, with the mean Capital Exercise bank being less engaged in customer lending and generating less of its revenue from interest income than the mean Non-Capital Exercise bank. Moreover, the mean Capital Exercise bank has a lower core tier 1 ratio and is significantly less reliant on customer deposits (i.e. more reliant on wholesale funding) than the mean Non-Capital Exercise bank. These large differences between Capital Exercise banks

and Non-Capital Exercise banks regarding important characteristics emphasize the necessity of employing a matching procedure.

For our *full sample matching* strategy, we match four Non-Capital Exercise banks to each Capital Exercise bank based on the Malahanobis distance of the six matching covariates described above. Panel B of Table III shows the mean values of Capital Exercise banks and control group banks based on our full sample matching specification. The matching procedure significantly reduces the differences between Capital Exercise banks and Non-Capital Exercise banks, especially with regard to our measures for banks' business models. While Capital Exercise banks are still bigger than control group banks, this matching procedure reduces the difference from Capital Exercise banks being more than 18 times bigger to Capital Exercise banks being roughly 4 times bigger. To address concerns that our results might be driven by bank size, we employ the *overlap matching strategy*, which includes all banks larger than the smallest Capital Exercise bank and smaller than the largest Non-Capital Exercise bank, and matches one Non-Capital Exercise bank to each Capital Exercise bank based on asset size only. Panel C of Table III shows that this matching strategy reduces the size difference to 5 billion euro, which is statistically insignificant. A further concern might be that our results are driven by country-specific factors, such as differences in macroeconomic environments or regulatory interventions. To rule this out, we employ the *within country matching* strategy in Panel D, which matches the two largest Non-Capital Exercise banks to the two smallest Capital Exercise banks within each country using the threshold sample. To specifically address the concern that our results are driven by banks from GIIPS countries, which were especially exposed to the European sovereign debt crisis, we employ the *within region matching* strategy in Panel E, which uses the threshold sample and matches Capital Exercise banks to Non-Capital Exercise banks around the selection threshold within the same region (GIIPS countries and Non-GIIPS countries). Although the matching strategies reduce the differences between the two groups of banks, some differences remain significant. Abadie and Imbens (2002) show that inexact matches generate a bias in the matching estimator. To address this problem, we use the Abadie and Imbens (2002) bias-corrected matching estimator. Using a two-step procedure, this estimator removes the bias in the coefficients stemming from imperfect matches on continuous covariates.

A.2. Adjustment of Core Tier 1 Ratios

We first examine whether Capital Exercise banks did indeed increase their core tier 1 ratios in response to higher capital requirements, and whether they did so via increasing their levels of capital (adjustment via the numerator) or via reducing risk-weighted assets (adjustment via the denominator). The underlying assumption of a difference-in-differences estimator requires that Capital Exercise banks and matched control group banks would follow a similar trend in absence of the treatment ("parallel trend assumption"). Figure 3 shows the evolution of mean core tier 1 ratios relative to 2010 for Capital Exercise banks (red solid line) and the matched control groups (blue solid line) for each of the four matching strategies. Figure 4 and Figure 5 show the evolution of mean core tier 1 capital and mean risk-weighted assets relative to 2010, respectively. The dashed lines indicate the extrapolated pre-treatment trends and the dotted lines indicate the 95% confidence intervals. As can be seen in Panel A of Figure 3, both Capital Exercise banks and control group banks in the full sample increase their core tier 1 ratios up to 2010, the year immediately prior to the capital exercise. Starting in 2011, Capital Exercise banks begin to increase their core tier 1 ratios significantly more than banks in the matched control group. Moreover, a comparison of the extrapolated pre-treatment trends with the actual core tier 1 ratios shows that the Capital Exercise banks strongly diverge from their pre-treatment trend after the capital exercise, while banks in the control group follow a fairly similar path in the post-treatment period. Panels B-D of Figure 3 show similar patterns for the other three matching strategies. As shown in Figure 4, Capital Exercise banks did not increase their core tier 1 ratios relative to the matched control groups by increasing their levels of core tier capital, but instead, as shown in Figure 5, by significantly reducing risk-weighted assets.

[Figure 3, Figure 4, and Figure 5 about here]

Table IV reports formal tests for the differences in pre-treatment trends between Capital Exercise banks and matched control group banks. As can be seen in Panel A, Capital Exercise banks increased their core tier 1 ratios significantly more than matched control group banks in the full sample over the period from 2008 to 2010 due to a higher reduction in risk-weighted assets over this period. Panels B-D of Table IV show that the *overlap matching* and *within country matching* strategies result in parallel pre-treatment trends for core tier 1 ratios, core tier 1 capital, and

risk-weighted assets, as can also be seen in Panels B-D of Figure 4 and Figure 5. The advantage of these three matching strategies is that they result in a comparison of more similar banks than in the full sample, at the cost of a smaller sample size. Thus, we report all results of the bank-level analysis for both the *full sample matching* strategy and the *overlap matching* strategy.[19]

[Table IV about here]

For the different matching strategies, we estimate the differences in the changes in the core tier 1 ratios, in the logarithms of core tier 1 capital, and in the logarithms of risk-weighted assets from the period before to the period after the capital exercise between Capital Exercise banks and banks in the matched control groups. The first column of Panel A of Table V shows how both Capital Exercise banks and banks in the matched control group adjust their core tier 1 ratios around the 2011 EBA capital exercise. In each panel, Row 1 reports the before-after differences for Capital Exercise banks, Row 2 the before-after differences for control group banks, and Row 3 the bias-corrected Abadie and Imbens (2002) matching estimator for the average treatment effect on the treated (ATT). Both Capital Exercise banks and control group banks increased their core tier 1 ratios in the two years after the capital exercise, reflecting a general upward trend among European banks, which can also be seen in Figure 3. However, while control group banks increased their core tier 1 ratios by only 1.78 percentage points on average, Capital Exercise banks did so by 3.02 percentage points and thus significantly more than banks not subject to higher capital requirements. The ATT equals 1.86 percentage points and is significant at the 1% level, indicating that the increase in capital requirements did indeed affect the core tier 1 ratios of banks selected into the capital exercise.

[Table V about here]

The second column of Panel A of Table V shows that Capital Exercise banks increased their levels of core tier 1 capital by 19% around the 2011 EBA capital exercise. However, as the comparison with the matched control group indicates, this increase seems to reflect a general development in the European banking system rather than an effect of the capital exercise. European banks not

[19]For the sake of brevity, we report the results for the *within country matching* strategy and the *within region matching* strategy only for Section III.A.2. All other results are available from the authors upon request.

selected into the capital exercise exhibited an almost identical percentage increase in their levels of core tier 1 capital, rendering the ATT insignificant. This finding provides evidence that Capital Exercise banks did not respond to the increase in capital requirements by raising new capital. In contrast, there is a significant difference in the change of risk-weighted assets between Capital Exercise banks and matched control group banks around the capital exercise, as can be seen in the third column of Panel A of Table V. While Capital Exercise banks reduced their levels of risk-weighted assets by 10 percentage points over the sample period, control group banks kept their levels of risk-weighted assets unchanged. The ATT indicates that Capital Exercise banks reduced their risk-weighted assets by 16 percentage points compared to banks in the matched control group which were not subject to an increase in capital requirements. The analog matching results of the *overlap matching* strategy in Panel B, the *within country matching* strategy in Panel C, and the *within region matching* strategy in Panel D of Table V show that our results are robust to concerns of bank size, country-specific factors, and exposure to the European sovereign debt crisis, respectively. In all cases, the matching results suggest that Capital Exercise banks responded to the increase in capital requirements by reducing their risk-weighted assets compared to banks in the control group.

The combined findings in Table V are the first central result of the bank-level analysis in our paper. They provide evidence that banks, when faced with an increase in capital requirements, adjust their capital ratios by reducing their levels of risk-weighted assets (adjustment via the denominator) rather than by raising new capital (adjustment via the numerator).[20]

A.3. Adjustment of Core Tier 1 Capital and Risk-Weighted Asset Components

The previous findings show that Capital Exercise banks increased their core tier 1 ratios relative to the matched control group by reducing their levels of risk-weighted assets, but not by increasing their levels of core tier 1 capital. In this section, we study in detail the adjustments of the components of both core tier 1 capital and risk-weighted assets. Did Capital Exercise banks issue new equity or did they increase retained earnings? Did they reduce corporate exposures or other

[20]When using the sample of all 61 Capital Exercise banks, we find that Capital Exercise banks increased their core tier 1 ratio by 2.13 percentage points and reduced their risk-weighted assets by 15 percentage points compared to banks in the matched control group. Both estimates are significant at the 1% level. Furthermore, we find no significant differences with regard to the changes in core tier 1 capital.

components of risk-weighted assets? We supplement the SNL data on the components of core tier 1 capital and risk-weighted assets by hand-collecting missing data from the banks' annual reports. Furthermore, since SNL does not contain a breakdown of the components of credit risk-weighted assets (cRWA), we hand-collect this data from the banks' Pillar 3 disclosure reports. Table A3 in the online appendix shows a regulatory bank balance sheet and the decomposition of core tier 1 capital and risk-weighted assets used in this section.

Core tier 1 capital consists of tier 1 common equity, with the share capital and share premium as main components, and regulatory adjustments, which are deducted from tier 1 common equity.[21] Goodwill and any other intangible assets are, for example, deducted from tier 1 common equity because of the high degree of uncertainty of their value in case of a default. Table VI shows that both Capital Exercise and control group banks increased their tier 1 common equity by increasing their retained earnings and share capital, although control group banks did this at a faster rate. Instead, Capital Exercise banks reduced their regulatory adjustments more than the control group.

[Table VI about here]

Risk-weighted assets consist of the risk-weighted assets for credit risk, market risk and operational risk. Table VII presents the results for the decomposition of banks' risk-weighted assets and shows that Capital Exercise banks reduced their risk-weighted assets for credit risk. This implies that Capital Exercise banks adjusted their loan portfolio, instead of their trading portfolio. Using hand-collected data from the banks' Pillar 3 disclosure reports, we further decompose the risk-weighted assets for credit risk into credit risk-weighted assets for corporate exposures, retail exposures (incl. exposures to SMEs), sovereign exposures and other exposures.[22]. Table VIII shows that the reduction in credit risk comes exclusively from a reduction in corporate and retail exposures.

[Table VII and Table VIII about here]

[21] Capital regulation requires to deduct items from tier 1 common equity that limit the ability to absorb losses. The accounting rules governing these adjustment allow bank to manage these deductions to maximize their core tier 1 capital. Lubberink (2014) shows, using a sample of US Banks, that low-solvency banks use adjustments to increase tier 1 capital, and high-solvency banks display a higher incidence of regulatory adjustments that decrease tier 1 capital.

[22] "Other exposures" include risk-weighted assets for all exposure categories not included in retail, corporate, or sovereign exposures (e.g. off-balance sheet positions).

A.4. Risk Reduction versus Asset Shrinking

Banks could reduce risk-weighted assets by changing the composition of their corporate and retail portfolios from riskier assets into safer assets, by recalibrating their internal risk-weight models, or by shrinking their assets. Asset shrinking has potential negative effects on the real economy if a large fraction of banks simultaneously decides to reduce lending. We construct two tests to examine which mechanism drives the reduction in risk-weighted assets. Both risk reduction and model recalibration would result in a lower average risk weight (Risk-Weighted Assets/Total Assets) while keeping total assets constant. Pure asset shrinking would result in a constant average risk weight and a drop in total assets. Table IX reports the matching estimation results for two different measures of banks' asset risk as the outcome variable. The first column shows that there is no statistically significant difference in the changes of the RWA/TA ratio between Capital Exercise banks and banks in the matched control group. Similarly, the second column shows that there is also no significant treatment effect with regard to loan loss reserves relative to outstanding customer loans.[23]

[Table IX about here]

Column 3 of Table IX show that Capital Exercise banks reduced total assets by 14 percentage points compared to banks in the matched control group. Moreover, the matching estimator in Column 4 of Table IX indicates that Capital Exercise banks reduced outstanding customer loans by 12 percentage points compared to the matched control group of banks not subject to an increase in capital requirements. Finally, we also document a negative treatment effect on security holdings of Capital Exercise banks. However, as customer loans make up 60% of the average Capital Exercise bank's balance sheet while security holdings only make up 27%, the asset shrinking behavior of Capital Exercise banks can mainly be attributed to a relative reduction in outstanding customer loans.

[23] Behn, Haselmann, and Vig (2016) show that the RWA-to-loans ratio is 10 to 15 percentage points lower for loans under IRB, even for loans to the same firm in the same year. Banks' Pillar 3 reports contain information about the share of credit risk-weighted assets calculated under the IRB approach (Credit Risk-Weighted Assets via IRB / Total Credit Risk-Weighted Assets). However we do not find a significant difference in this regard between Capital Exercise banks and the banks in the matched control groups (result not reported).

A.5. Why are Banks Reluctant to Raise Equity?

We now turn to the question *why* banks are reluctant to raise equity. Admati, DeMarzo, Hellwig, and Pfleiderer (2017) show that if banks can repurchase subordinated debt, existing shareholders find it preferable to deleverage by shrinking assets and repurchasing subordinated debt than by issuing new equity. The economic mechanism behind Admati, DeMarzo, Hellwig, and Pfleiderer (2017) is a debt overhang problem: highly levered banks resist new equity issuances and may forgo positive NPV projects because the cash flows will accrue to debtholders.

A direct empirical implication of Admati, DeMarzo, Hellwig, and Pfleiderer (2017) is that banks with higher levels of subordinated debt prefer asset shrinking and the repurchase of subordinated debt over a pure recapitalization.[24] We test this prediction by splitting our sample into banks with above and below median levels of subordinated debt (hybrid securities and other subordinated debt) and separately study the effect of the capital exercise on the change in the core tier 1 ratio and its components in each subsample. Columns 1 to 3 of Table Table X show that Capital Exercise banks with above median levels of subordinated debt increased their core tier 1 ratio by reducing risk-weighted assets, while Capital Exercise banks with below median levels increased their capital ratios by increasing their levels of core tier 1 capital. This empirical finding is in line with the theoretical predictions of Admati, DeMarzo, Hellwig, and Pfleiderer (2017).

[Table X about here]

We furthermore test whether Capital Exercise banks with high levels of subordinated debt bought back their subordinated debt. The evidence is somewhat mixed. Column 4 of Table X shows that while banks with high levels of subordinated debt reduce their holdings of subordinated debt by a large magnitude in the full sample, the coefficient is not significant, albeit large in magnitude, in the overlap sample.

Capital Exercise banks could also be reluctant to issue new equity due to asymmetric information concerns. If investors interpret a bank's decision to issue equity as a signal that the bank's stock is overvalued, then banks might want to avoid sending out such a negative signal. Moreover, in the presence of debt overhang, the issuance of new equity might lead to a wealth transfer from

[24] See Proposition 9 (Multiple Classes of Existing Debt) in Admati, DeMarzo, Hellwig, and Pfleiderer (2017).

existing stockholders to bondholders. We would therefore like to test how equity issuances by Capital Exercise banks and Non-Capital Exercise banks affect the banks' stock and bond prices. We collect data on common equity issuances of banks in our sample from the SNL Capital Issuance Database and data on banks' stock and bond prices from Datastream. However, during the period of the capital exercise only 7 Capital Exercise banks and 6 control group banks announced equity issuances. Hence, it is difficult to draw strong conclusions from this analysis beyond the fact that seasoned equity issuances in the wake of the capital exercise were rare. In Table A6 and Table A7 in the online appendix, we present the results of short-term and long-term event studies for abnormal stock and bond returns and provide a more detailed discussion of this analysis. We find little evidence for negative announcement effects, but some evidence for a positive abnormal long-term bond performance for Capital Exercise banks which issued equity during the capital exercise. Thus, our event study results point toward debt overhang and not asymmetric information as the underlying economic reason for why Capital Exercise banks were reluctant to issue equity.

B. Loan-Level Results

To rule out that the reduction in outstanding customer loans of Capital Exercise banks shown in Section III.A is driven by demand effects, we employ a modified version of the Khwaja and Mian (2008) estimator, which estimates the change in outstanding syndicated loan volumes of Capital Exercise banks and control group banks to Country×Industry firm clusters (see Acharya, Eisert, Eufinger, and Hirsch (2016)). Figure 6 shows the trends in outstanding syndicated loan volumes for Capital Exercise banks and control group banks relative to 2011-Q2, the quarter immediately prior to the capital exercise. There is a parallel upward trend in syndicated loan volumes of both groups of banks in the quarters leading up to the capital exercise. Starting in the third quarter of 2011, loan volumes of Capital Exercise banks started to stagnate and then decrease, while loan volumes for banks in the matched control group kept increasing.

[Figure 6 about here]

Table XI presents the results of the difference-in-differences regression equation (1) in the spirit of Khwaja and Mian (2008) for the intensive margin sample. The first column of Table XI shows that Capital Exercise banks reduced their exposures in the syndicated loan market by 9 percentage points

after the capital exercise compared to banks in the control group. This specification includes fixed effects for banks' home countries, which absorb unobserved shocks affecting all banks headquartered in a given country. The second column of Table XI includes bank-specific control variables to address concerns that differences in bank characteristics are correlated with changes in credit demand, in particular bank size. In this specification, the magnitude of the coefficient increases to 14 percentage points.

Credit demand shocks could conceivably also occur outside the bank's home country. For example, Deutsche Bank might reduce its exposures to Spanish firms due to changes in credit demand in Spain. Similarly, credit demand shocks could occur at the industry level and our results might be driven by Capital Exercise banks having different exposures to different industries than Non-Capital Exercise banks. To address these concerns, we include Borrower Country fixed effects in the third column, Industry fixed effects in the fourth column, and Borrower Country $\times$ Industry fixed effects in the fifth column respectively. In the fifth and strongest specification, which rules out that our results are driven by firm-cluster specific demand shocks, we find that Capital Exercise banks reduced their exposures in the syndicated loan market by 17 percentage points compared to banks in the control group. This large negative effect of higher capital requirements on bank lending confirms recent findings in the literature. Fraisse, Lé, and Thesmar (2015) report that a "1 percentage point increase in capital requirements reduces lending by 10%". Since the capital exercise constituted an increase in capital requirements of 4 percentage points from 5% to 9%, our results are in line with these findings.

[Table XI about here]

These results are consistent with the bank-level analysis in Section III.A. Capital Exercise banks responded to the increase in capital requirements by reducing outstanding corporate loans. The loan-level part of the paper shows that this reduction can be attributed to a reduction in credit supply and is not driven by demand effects.

C. Firm-Level Results

Ultimately, the degree to which a reduction in credit supply from Capital Exercise banks implies real effects at the firm level depends on the extent to which other banks, not subject to higher capital

requirements, pick up the slack. To investigate whether such substitution occurs, we divide our sample of firms into "CEB dependent firms" with an above median dependence on credit supply from Capital Exercise banks as measured by the CEB borrowing share (our treatment group), and "Non-CEB dependent firms" with a below median dependence on credit supply from Capital Exercise banks (our control group pool). The average CEB borrowing share of a firm in the sample is 54% with a standard deviation of 36.5 percentage points. Since CEB dependent firms might differ from Non-CEB dependent firms along a number of important characteristics, we employ a difference-in-differences matching methodology analog to the one used in the bank-level part.

Table XII shows the pre-treatment mean values of the matching covariates for CEB-dependent firms, Non-CEB-dependent firms, and control group firms as of end of 2010, the year immediately prior to the capital exercise. The paper uses the Student's t-test to test for differences in means between the groups.

[Table XII about here]

Panel A of Table XII compares the 952 CEB-dependent firms with 1,006 Non-CEB-dependent firms in the unmatched sample. CEB-dependent firms are on average larger than Non-CEB-dependent firms in terms of total assets, have a higher ratio of fixed assets to total assets (tangibility) and a higher leverage ratio. These differences between CEB-dependent firms and Non-CEB-dependent firms emphasize the necessity of employing a matching procedure. We match four Non-CEB-dependent firms to each CEB-dependent firm based on the Mahalanobis distance of all matching covariates as of end of 2010. This matching procedure renders all differences between CEB-dependent firms and Non-CEB dependent firms insignificant at the 5% level.

Figure 7, Figure 8, and Figure 9 show the evolution of total assets, fixed assets, and sales relative to 2010 for unlisted CEB-dependent firms and firms in the matched control group, respectively. Each of the figures show that the corporate policies of CEB-dependent firms and Non-CEB-dependent firms developed similarly up to 2010, the year prior to the capital exercise. Starting in 2011, CEB-dependent firms started to exhibit lower asset-, investment-, and sales growth than firms in the matched control group.

[Figure 7, Figure 8, and Figure 9 about here]

We estimate the differences in changes in the logarithms of total assets, fixed assets, and sales from the period before to the period after the capital exercise between CEB-dependent firms and firms in the matched control group. As we expect results to be stronger for firms which are less likely to substitute a reduction in credit supply with other sources of funding, we also split our sample into listed and unlisted firms and report results separately. Panel A of Table XIII shows how the 2011 EBA capital exercise affected total assets, investment, and sales of all firms in our sample. Row 1 reports the before-after differences for CEB dependent firms, Row 2 the before-after differences for control group firms, and Row 3 the bias-corrected Abadie and Imbens (2002) matching estimator for the average treatment effect on the treated (ATT). The average treatment effect shows that being dependent on funding from Capital Exercise banks had a significant negative effect on asset-, investment-, and sales growth. On average, CEB dependent firms grew by 4 percentage points less, exhibited 6 percentage points less investment growth, and 5 percentage points less sales growth than firms in the matched control group less reliant on funding from Capital Exercise banks.

[Table XIII about here]

Panel B and C of Table XIII report results separately for the subsample of listed and unlisted firms respectively. As expected, our results are driven by the unlisted firms in our sample which are unable to raise public equity and thus have less alternative sources of funding. We find that unlisted CEB-dependent firms exhibited 6 percentage points less asset growth and 9 percentage points less sales growth than unlisted firms in the matched control group, while we find no significant difference for the sample of listed firms. Thus, our results show that the reduction in credit supply by Capital Exercise banks in response to higher capital requirements yielded significant negative effects for firms which obtained a large share of their funding from Capital Exercise banks. We conclude that the EBA capital exercise had negative effects on the real economy.

IV. Robustness Checks

In this section, we provide additional results and conduct additional tests, showing that our results from the bank- and loan-level part are robust to a number of alternative specifications.

A. Bank-Level Robustness Checks

A.1. Placebo Test

Both the *within country* and *within region* matching strategy exploit variation within regions to identify the effect of higher capital requirements on bank behavior and suggest that those effects are present also for banks in Northern Europe. Nevertheless, there may still be a lingering concern that our results might be driven by Capital Exercise banks' exposure to the European sovereign debt crisis, which started in 2010 (Popov and Van Horen, 2015). If differences in balance sheet adjustments between Capital Exercise banks and control group banks are indeed driven by the sovereign debt crisis, there should be a significant difference between the two groups in the period prior to the capital exercise.

In order to investigate this issue, we conduct a placebo matching exercise for the period of the start of the sovereign debt crisis (2009-2010) and show that Capital Exercise banks and control group banks exhibit a similar change in their core tier 1 ratios during this placebo period. The results from this placebo test are reported in Table XIV and show that Capital Exercise banks did not change their core tier 1 ratios, nor their levels of core tier 1 capital, nor their levels of risk-weighted assets differently than banks in the matched control group over the same period. While Capital Exercise banks reduced their risk-weighted assets by 6 percentage points more than banks in the matched control group, this change is smaller in magnitude compared to the risk-weighted assets reduction of 16 percentage points in Section III and not significant at the 5% level. The placebo test therefore shows that the differences between Capital Exercise banks and control group banks observed in the main analysis do not appear in the period between 2009 and 2010 before the capital exercise and can therefore not be attributed to the European sovereign debt crisis.

[Table XIV about here]

A.2. Strongly versus Weakly Capitalized Banks

The EBA capital exercise required Capital Exercise banks to increase their core tier 1 ratios to 9% over the period from December 2011 to June 2012. Capital Exercise banks, which already met this criterion in December 2011, also faced higher capital requirements, but were not required by the EBA to further increase their core tier 1 ratios beyond the target ratio of 9%. Therefore, our

results should be driven by weakly capitalized Capital Exercise banks. To test this prediction, we divide the sample into a subsample of banks with a pre-treatment core tier 1 ratio below 9% (ex-ante below) and a subsample of banks with a pre-treatment core tier 1 ratio above or equal to 9% (ex-ante above). Within these subsamples, we employ the same matching procedure as before and match four Non-Capital Exercise banks to each Capital Exercise bank based on the six matching covariates. Panel A of Table XV shows the results for the subsample of weakly capitalized banks, and Panel B of Table XV the results for the subsample of strongly capitalized banks. As expected, our results are stronger for banks with a pre-treatment core tier 1 ratio below 9%. Within the subsample of weakly capitalized banks, the unconditional difference-in-differences estimator shows that Capital Exercise banks increased their core tier 1 ratio by 2.02 percentage points more than banks in the matched control group, compared to only 1.24 percentage points in the subsample of strongly capitalized banks.[25] They did so by reducing their risk-weighted assets by 19 percentage points relative to the matched control group, which is higher than the estimate in the full sample and higher than the estimate in the subsample of strongly capitalized banks. Although sufficiently capitalized Capital Exercise banks did not have to increase their core tier 1 ratio in response to the capital exercise, they might have done so for precautionary reasons and in line with the buffer view of bank capital structure (Gropp and Heider, 2010).

[Table XV about here]

A.3. Regression Discontinuity Design

The empirical setting of the capital exercise seems to lend itself to a regression discontinuity (RD) design. Given the EBA's explicit selection rule based on bank size, the running variable is defined as bank size as a fraction of the country-specific size cutoff for being included in the capital exercise. The RD approach then exploits the country-specific selection threshold by comparing the change in core tier 1 ratios for banks just above and just below the threshold. The internal validity of an RD approach relies on two identifying assumptions: That banks could not manipulate the running variable and therefore whether they are included in the capital exercise or not; and that

[25] Note that the matching estimator produces extreme results in Table XV due to the bias correction combined with a very low number of observations. However, the bias correction works in favor of our results that weakly capitalized Capital Exercise banks reduced their risk-weighted assets and did not increase core tier 1 capital compared to banks in the matched control group.

other bank characteristics affecting the outcome variables are continuous around the cutoff. Since the EBA capital exercise came unexpected in October 2011 and since selection into the exercise was based on banks' total assets as of end of 2010, it is unlikely that banks could manipulate their inclusion in the capital exercise.[26] Assessing the continuity of other bank characteristics around the cutoff requires the choice of a bandwidth, that is a definition of what it means to be "just above or just below the cutoff". Bandwidth selection is an important decision in the implementation of an RD design. For our analysis, we use the optimal bandwidth selection procedure proposed by Calonico, Cattaneo, and Titiunik (2014), which results in a sample of 22 banks around the cutoff. This small number of observations around the cutoff, combined with large variation in other bank characteristics around the cutoff, makes inference based on an RD design problematic in our setting. In the online appendix, we present the results for the RD approach in Table A5 and provide a more detailed discussion of the empirical challenges. We find that our results are generally robust to using an RD design, albeit of limited informativeness when using the optimal bandwidth selection criterion.

B. Loan-Level Robustness Checks

In the loan-level part, we studied the intensive margin sample of country-industry firm clusters to which Capital Exercise banks lent both before and after the capital exercise. We now also provide results for the extensive margin sample and study whether banks stopped or started lending to specific country-industry firm clusters. To investigate this, we estimate the following regression specification:

$$Y_{bij} = \alpha + \beta \cdot \text{CEB}_{bi} + \gamma X_{bi} + \eta_i + \eta_j + \epsilon_{bij} \tag{3}$$

where Y_{bij} is either the dummy variable $Exit_{bij}$, which takes on the value of 1 if bank b from country i stopped lending to firm cluster j after the capital exercise, and 0 otherwise; or the dummy variable $Entry_{bij}$, which takes on the value of 1 if bank b from country i started lending to firm cluster j after the capital exercise, and 0 otherwise. The variable CEB_{bi} takes on the value of 1 if the bank is part of the EBA capital exercise, and 0 otherwise. In addition, the specification includes bank

[26] In the online appendix, we discuss a formal manipulation test based on the procedure proposed in Cattaneo, Jansson, and Ma (2017).

characteristics as of 2010 (log total assets, core tier 1 ratio, customer loans as a share of total assets, net interest income as a share of total operating revenue, depository funding as a share of total assets, and net income over total assets) and firm cluster fixed effects η_j, which absorb all cluster-specific credit demand shocks.

The first three columns of Table XVI provide evidence that Capital Exercise banks did not stop lending to specific country-industry firm clusters after the capital exercise. The fourth column suggests that Capital Exercise banks may have been less likely to start lending to new clusters, however this result becomes insignificant after controlling for bank characteristics and borrower country-industry fixed effects. The results therefore show that the EBA capital exercise primarily affected lending on the intensive margin.

[Table XVI about here]

V. Conclusion

We exploit the EBA capital exercise as a quasi-natural experiment to study the effect of higher capital requirements on banks' balance sheet adjustments and the transmission of this effect to the real economy. Using different matching strategies which exploit the selection rule of the EBA capital exercise, we show that Capital Exercise banks increase their core tier 1 ratios more than Non-Capital Exercise banks in response to an increase in capital requirements. This suggests that the capital exercise was an effective policy instrument to improve the capitalization of the largest European banks.

But the capital exercise may also have been a somewhat blunt instrument, because our analysis further shows that banks do not raise their capital ratios by increasing their levels of core tier 1 capital, but by reducing their credit exposures to corporate and retail clients. Banks primarily shrank their total assets by reducing the supply of credit, rather than reducing risk. Consistent with debt overhang, we find that Capital Exercise banks with more subordinated debt are more likely to shrink assets and retire subordinated debt.

As a consequence, we show that firms which are more reliant on credit supplied by Capital Exercise banks exhibit lower asset-, investment-, and sales growth than firms less reliant on Capital Exercise banks. This suggests that firms were unable to fully substitute the reduction in credit

supply by Capital Exercise banks with other sources of financing. Capital Exercise banks cover more than 65% of the European banking sector. High switching costs or limited access to other sources of external funding could explain why firms dependent on these banks were not able to obtain other sources of external funding.

An important policy implication of our paper is that capital requirements which target the regulatory capital ratio have potentially adverse effects on the real economy. As suggested by Hanson, Kashyap, and Stein (2011), targeting the absolute amount of new capital that has to be raised instead of targeting the capital ratio could mitigate this problem, an approach which has been successfully applied in the U.S. stress tests conducted in 2009. In an institutional set up in which the recapitalization recommendations are difficult to verify and/or enforce, our paper highlights the risks associated with capital regulation that focuses on capital ratios as the policy target variable, while leaving it to the discretion of banks how to increase their capital ratios.

REFERENCES

Abadie, Alberto, and Guido W. Imbens, 2002, Simple and bias-corrected matching estimators for average treatment effects, *NBER Technical Working Paper* 283, 1–55.

Abadie, Alberto, and Guido W. Imbens, 2011, Bias-corrected matching estimators for average treatment effects, *Journal of Business & Economic Statistics* 29, 1–11.

Acharya, Viral V., Tim Eisert, Christian Eufinger, and Christian Hirsch, 2016, Real effects of the sovereign debt crisis in Europe: Evidence from syndicated loans, *Working Paper* .

Acharya, Viral V., Robert Engle, and Diane Pierret, 2014, Testing macroprudential stress tests: The risk of regulatory risk weights, *Journal of Monetary Economics* 65, 36–53.

Admati, Anat R., Peter M. DeMarzo, Martin F. Hellwig, and Paul Pfleiderer, 2017, The leverage ratchet effect, *Journal of Finance,* forthcoming.

Aiyar, Shekhar, Charles W. Calomiris, John Hooley, Yevgeniya Korniyenko, and Tomasz Wieladek, 2014, The international transmission of bank capital requirements: Evidence from the UK, *Journal of Financial Economics* 113, 368–382.

Almeida, Heitor, Murillo Campello, Bruno Laranjeira, and Scott Weisbenner, 2011, Corporate debt maturity and the real effects of the 2007 credit crisis, *Critical Finance Review* 1, 3–58.

Behn, Markus, Rainer Haselmann, and Vikrant Vig, 2016, The limits of model-based regulation, *ECB Working Paper Series* 1928.

Berg, Tobias, Anthony Saunders, and Sascha Steffen, 2016, The total cost of corporate borrowing in the loan market: Don't ignore the fees, *Journal of Finance* 71, 1357–1392.

Berger, Allen N., and Gregory F. Udell, 1994, Did risk-based capital allocate bank credit and cause a "credit crunch" in the United States?, *Journal of Money, Credit and Banking* 26, 585–628.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan, 2004, How much should we trust difference-in-differences estimates?, *The Quarterly Journal of Economics* 119, 249–275.

Bessembinder, Hendrik, Kathleen M. Kahle, William F. Maxwell, and Danielle Xu, 2009, Measuring abnormal bond performance, *Review of Financial Studies* 22, 4219–4258.

BIS, 2005, International convergence of capital measurement and capital standards: A revised framework November 2005.

BIS, 2015, Standards - Revised pillar 3 disclosure requirements January 2015.

Calonico, Sebastian, Matias D. Cattaneo, and Rocio Titiunik, 2014, Robust nonparametric confidence intervals for regression-discontinuity designs, *Econometrica* 82, 2295–2326.

Campello, Murillo, and Erasmo Giambona, 2013, Real assets and capital structure, *Journal of Financial Quantitative Analysis* 48, 1333–1370.

Campello, Murillo, and Mauricio Larrain, 2016, Enlarging the contracting space: Collateral menus, access to credit, and economic activity, *Review of Financial Studies* 29, 349–383.

Cattaneo, Matias D., Michael Jansson, and Xinwei Ma, 2017, Manipulation testing based on density discontinuity, *Working Paper* .

Célérier, Claire, Thomas Kick, and Steven Ongena, 2016, Changes in the cost of bank equity and the supply of bank credit, *Working Paper* .

De Haas, Ralph, and Neeltje Van Horen, 2012, Running for the exit? International bank lending during a financial crisis, *Review of Financial Studies* 26, 244–285.

De Marco, Filippo, and Tomasz Wieladek, 2015, The real effects of capital requirements and monetary policy: Evidence from the united kingdom, *Bank of England Staff Working Paper* 573.

EBA, 2011a, 2011 EU-wide stress test: Methodological note March 18, 2011.

EBA, 2011b, Eba recommendation on the creation and supervisory oversight of temporary capital buffers to restore market confidence (eba/rec/2011/1) December 8, 2011.

EBA, 2011c, Questions and answers October 26, 2011.

Eberhart, Allan C., and Akhtar Siddique, 2002, The long-term performance of corporate bonds (and stocks) following seasoned equity offerings, *Review of Financial Studies* 15, 1385–1406.

Fraisse, Henri, Mathias Lé, and David Thesmar, 2015, The real effects of bank capital requirements, *Working Paper* .

Greenlaw, David, Anil K. Kashyap, Kermit Schoenholtz, and Hyun Song Shin, 2012, Stressed out: Macroprudential principles for stress testing, *Chicago Booth Working Paper* 12-08, 1–51.

Gropp, Reint, and Florian Heider, 2010, The determinants of bank capital structure, *Review of Finance* 14, 587–622.

Hanson, Samuel G., Anil K. Kashyap, and Jeremy C. Stein, 2011, A macroprudential approach to financial regulation, *Journal of Economic Perspectives* 25, 3–28.

Hirtle, Beverly, Til Schuermann, and Kevin Stiroh, 2009, Macroprudential supervision of financial institutions: Lessons from the SCAP, *Federal Reserve Bank of New York Staff Reports* 409, 1–15.

Imbens, Guido W., 2014, Matching methods in practice: Three examples, *NBER Working Paper Series* 19959.

Jensen, Thais Lærkholm, 2015, The real effects of higher capital requirements: Evidence from danish firm-level data, *Working Paper* .

Jimenéz, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina, 2016, Macroprudential policy, countercyclical bank capital buffers and credit supply: Evidence from the spanish dynamic provisioning experiments, *Journal of Political Economy, forthcoming* .

Kahle, Kathleen M., and René M. Stulz, 2013, Access to capital, investment, and the financial crisis, *Journal of Financial Economics* 110, 280–299.

Kashyap, Anil K., Jeremy C. Stein, and Samuel Hanson, 2010, An analysis of the impact of "substantially heightened" capital requirements on large financial institutions, *Working Paper* .

Khwaja, Asim Ijaz, and Atif Mian, 2008, Tracing the impact of bank liquidity shocks: Evidence from an emerging market, *American Economic Review* 98, 1413–1442.

Kisin, Roni, and Asaf Manela, 2016, The shadow cost of bank capital requirements, *Review of Financial Studies* 29, 1780–1820.

Lubberink, Martien, 2014, A primer on regulatory bank capital adjustments, *Working Paper* .

Mésonnier, Jean-Stéphane, and Allen Monks, 2015, Did the EBA capital exercise cause a credit crunch in the Euro area?, *International Journal of Central Banking* June 2015, 75–117.

Ongena, Steven, Alexander A. Popov, and Neeltje Van Horen, 2016, The invisible hand of the government: 'Moral suasion' during the european sovereign debt crisis, *De Nederlandsche Bank Working Paper* 505.

Peek, Joe, and Eric S. Rosengren, 1997, The international transmission of financial shocks: The case of Japan, *American Economic Review* 87, 495–505.

Popov, Alexander, and Neeltje Van Horen, 2015, Exporting sovereign stress: Evidence from syndicated bank lending during the euro area sovereign debt crisis, *Review of Finance* 19, 1825–1866.

Vallée, Boris, 2016, Contingent capital trigger effects: Evidence from liability management exercises, *Working Paper* .

Van Rixtel, Adrian, and Gabriele Gasperini, 2013, Financial crises and bank funding: Recent experience in the Euro area, *BIS Working Papers 406* .

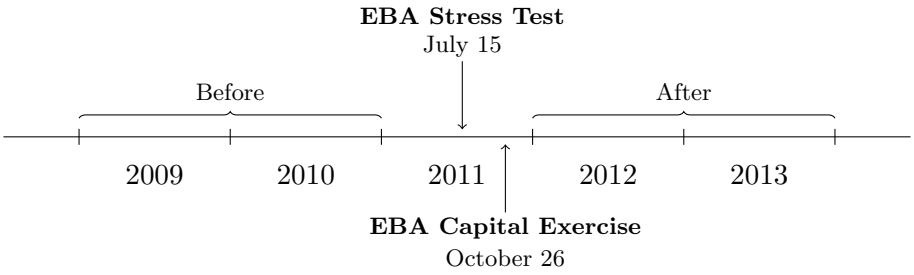

Figure 1. EBA Capital Exercise Timeline. This figure shows the timeline of the 2011 EBA capital exercise including our definition of the before and after period used in the paper.

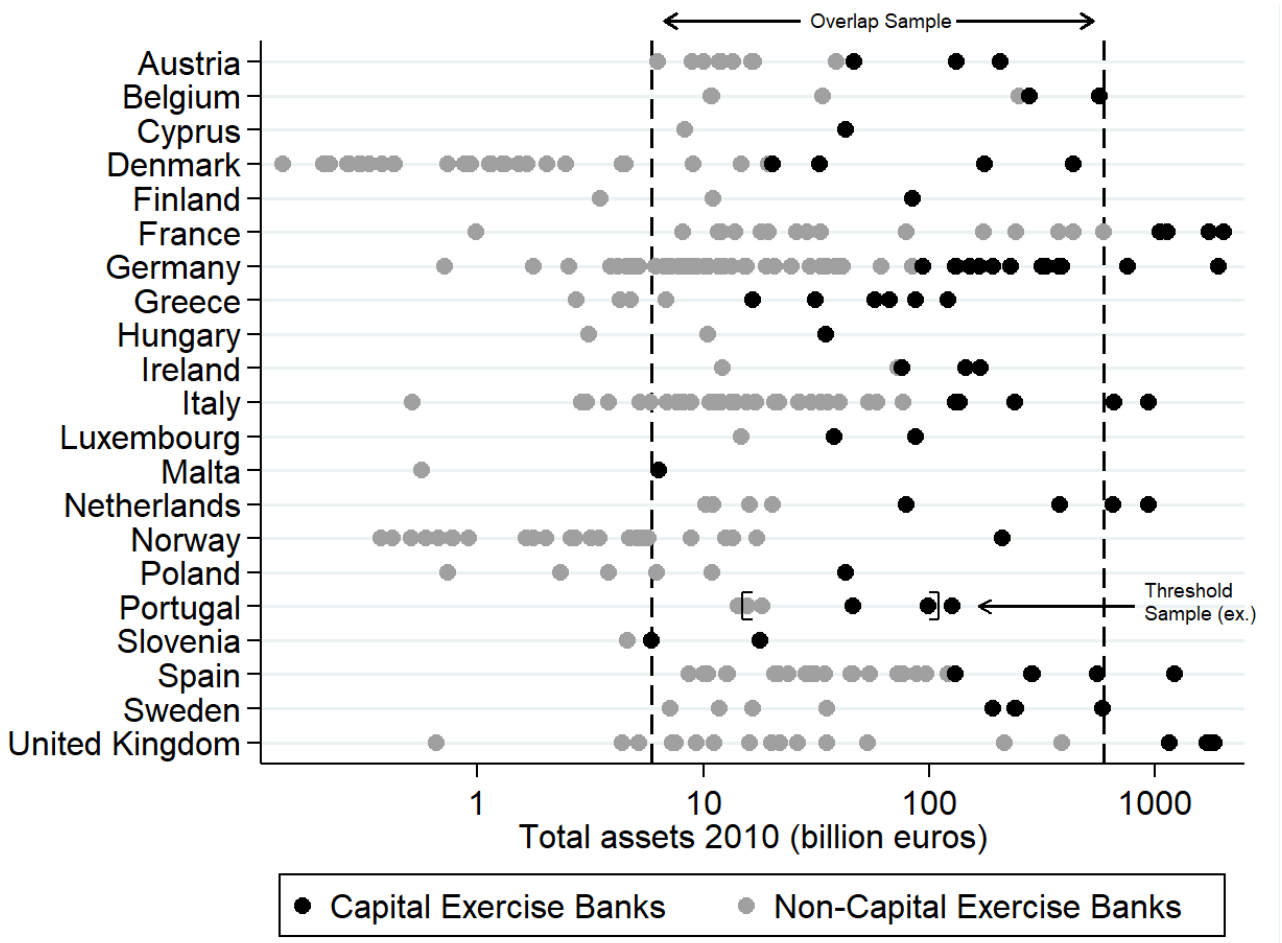

Figure 2. Bank Size Distribution by Country. This figure shows the bank size distribution (total assets as of end of 2010) of Capital Exercise banks and Non-Capital Exercise banks by country. The graph includes all ultimate parent banks headquartered in EBA supervised countries included in the SNL database. The figure illustrates the construction of the overlap sample and the threshold sample. The overlap sample includes all banks larger than the smallest Capital Exercise bank (left vertical line) and smaller than the largest Non-Capital Exercise bank (right vertical line). The threshold sample includes the two smallest EBA banks and the two largest Non-EBA banks in each country (e.g., Portugal).

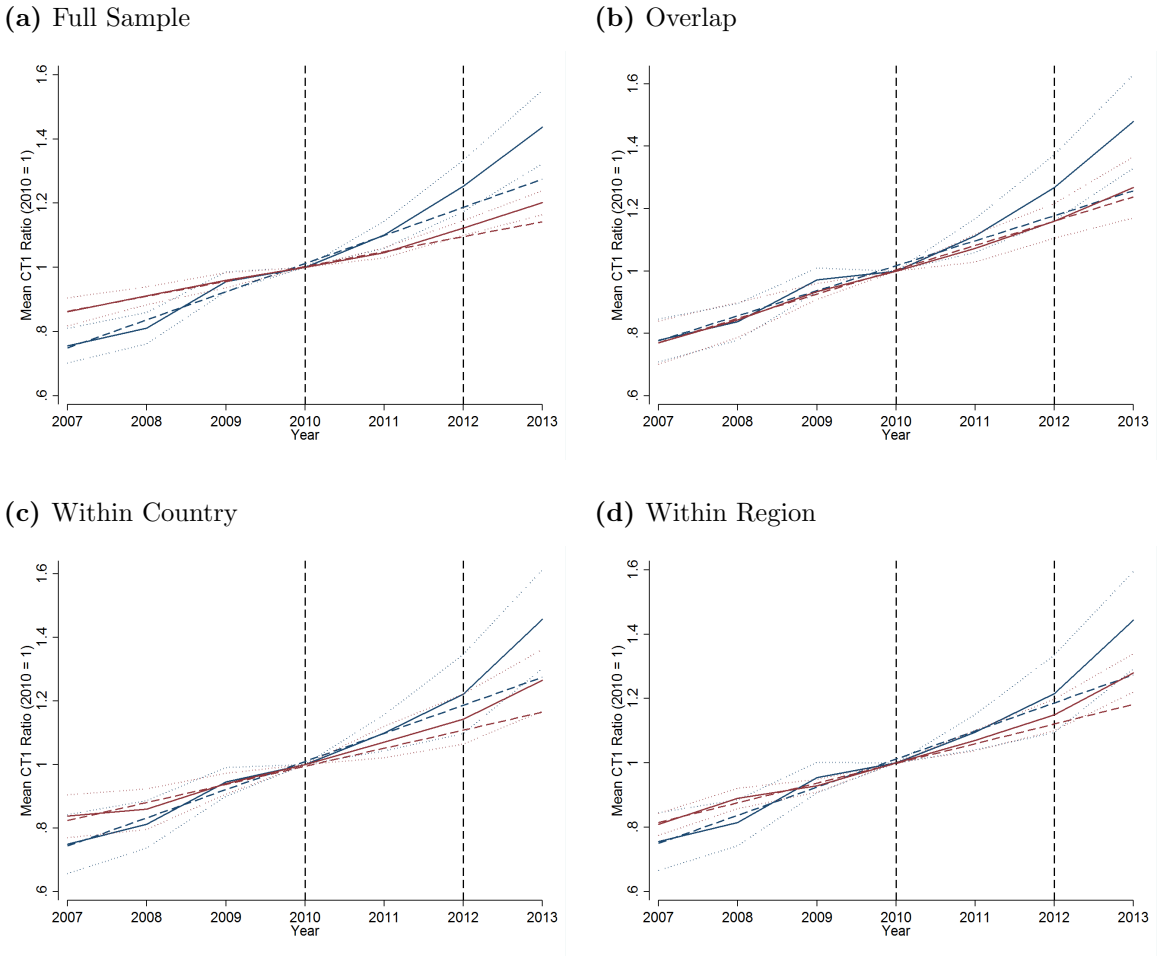

Figure 3. Core Tier 1 Ratios Over Time. This figure shows the evolution of the mean of core tier 1 (CT1) ratios over time for both 48 Capital Exercise banks in the treatment group (solid blue line) and 76 banks in the matched control group (solid red line) based on the four matching strategies. The two dashed vertical lines in each panel mark 2010 and 2012, the years immediately before and after the capital exercise. The dashed red and blue lines indicate the extrapolated pre-treatment trends and the dotted lines indicated the 95% confidence intervals.

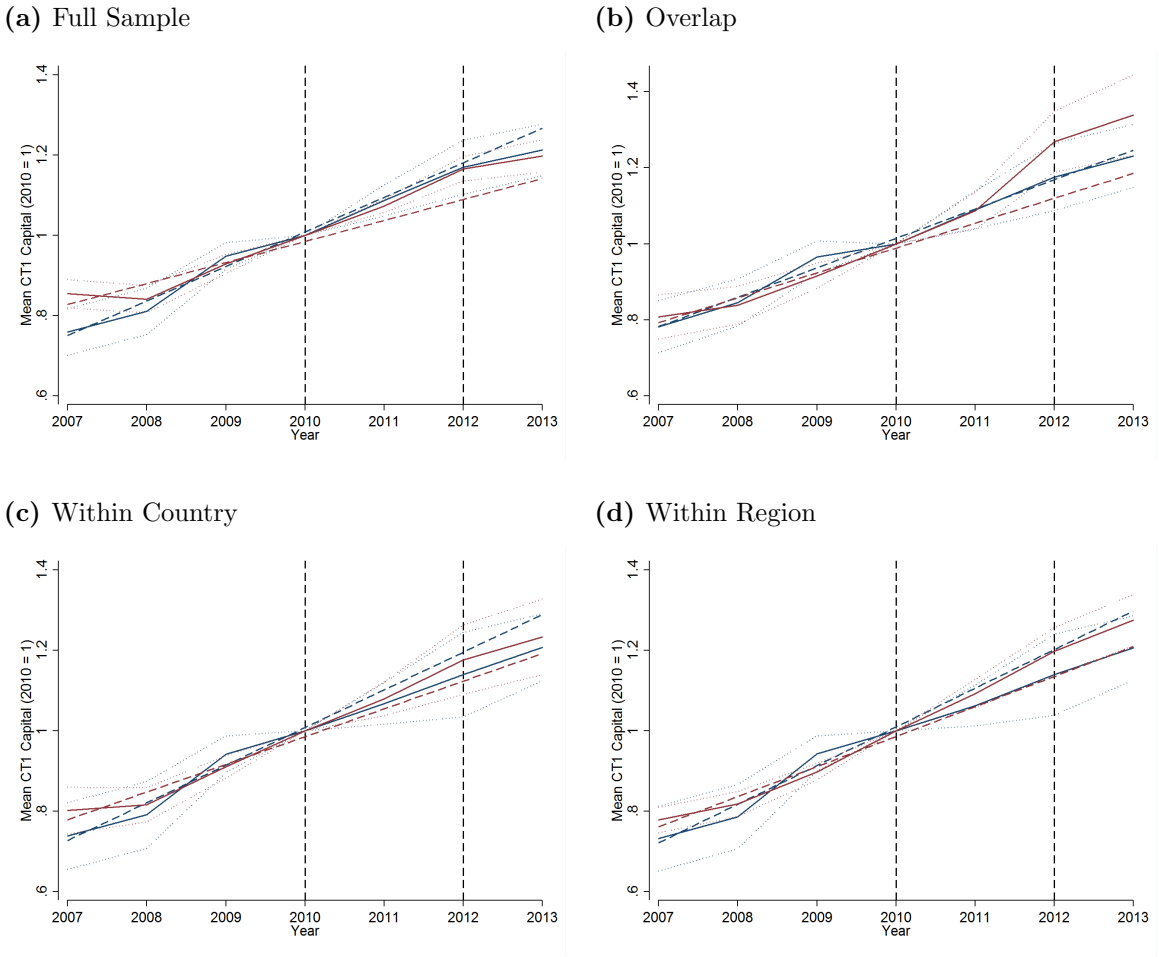

Figure 4. Core Tier 1 Capital Over Time. This figure shows the evolution of the mean of core tier 1 (CT1) capital over time for both 48 Capital Exercise banks in the treatment group (solid blue line) and 76 banks in the matched control group (solid red line) based on the four matching strategies. The two dashed vertical lines in each panel mark 2010 and 2012, the years immediately before and after the capital exercise. The dashed red and blue lines indicate the extrapolated pre-treatment trends and the dotted lines indicated the 95% confidence intervals.

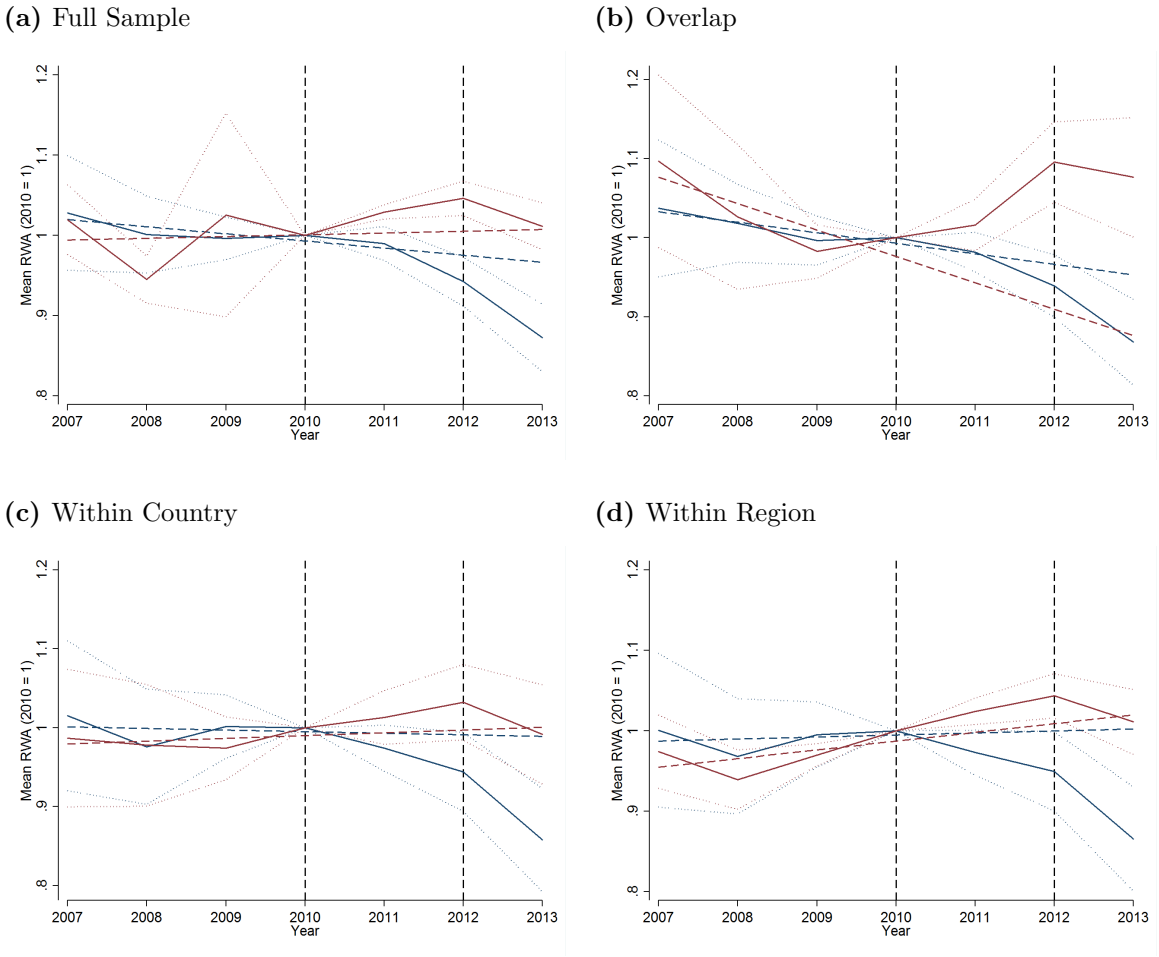

Figure 5. Risk-Weighted Assets Over Time. This figure shows the evolution of the mean of risk-weighted assets (RWA) over time for both 48 Capital Exercise banks in the treatment group (solid blue line) and 76 banks in the matched control group (solid red line) based on the four matching strategies. The two dashed vertical lines in each panel mark 2010 and 2012, the years immediately before and after the capital exercise. The dashed red and blue lines indicate the extrapolated pre-treatment trends and the dotted lines indicated the 95% confidence intervals.

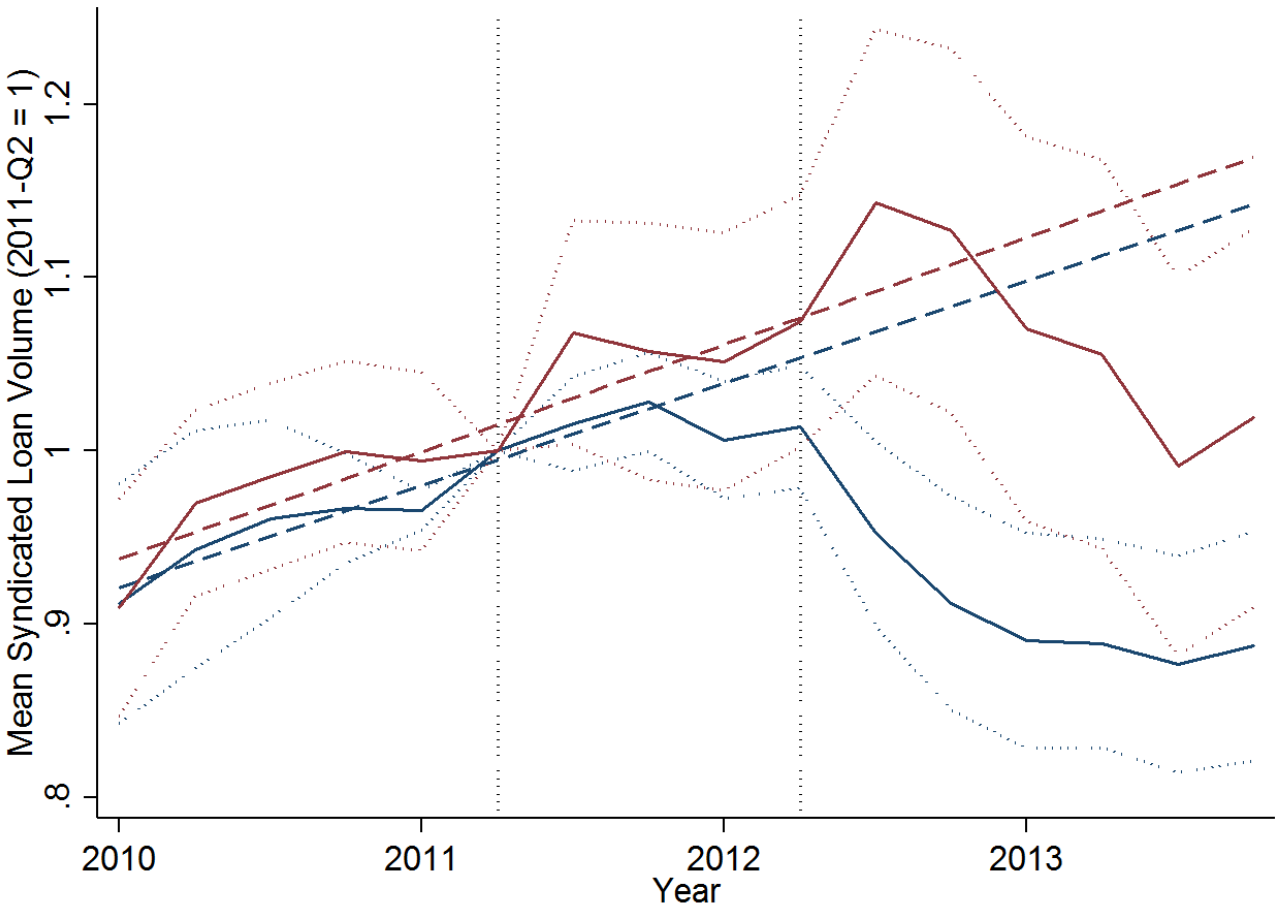

Figure 6. Syndicated Lending Over Time. This figure shows the loan volume of Capital Exercise banks (solid red line) and Non-Capital Exercise banks (solid blue line) in the syndicated loan market over the period 2010q1-2013q4, normalized to one in 2011Q2. The two dashed vertical lines in each panel mark 2011Q2 and 2012Q2, the years immediately before and after the capital exercise. The dashed red and blue lines indicate the extrapolated pre-treatment trends and the dotted lines indicated the 95% confidence intervals.

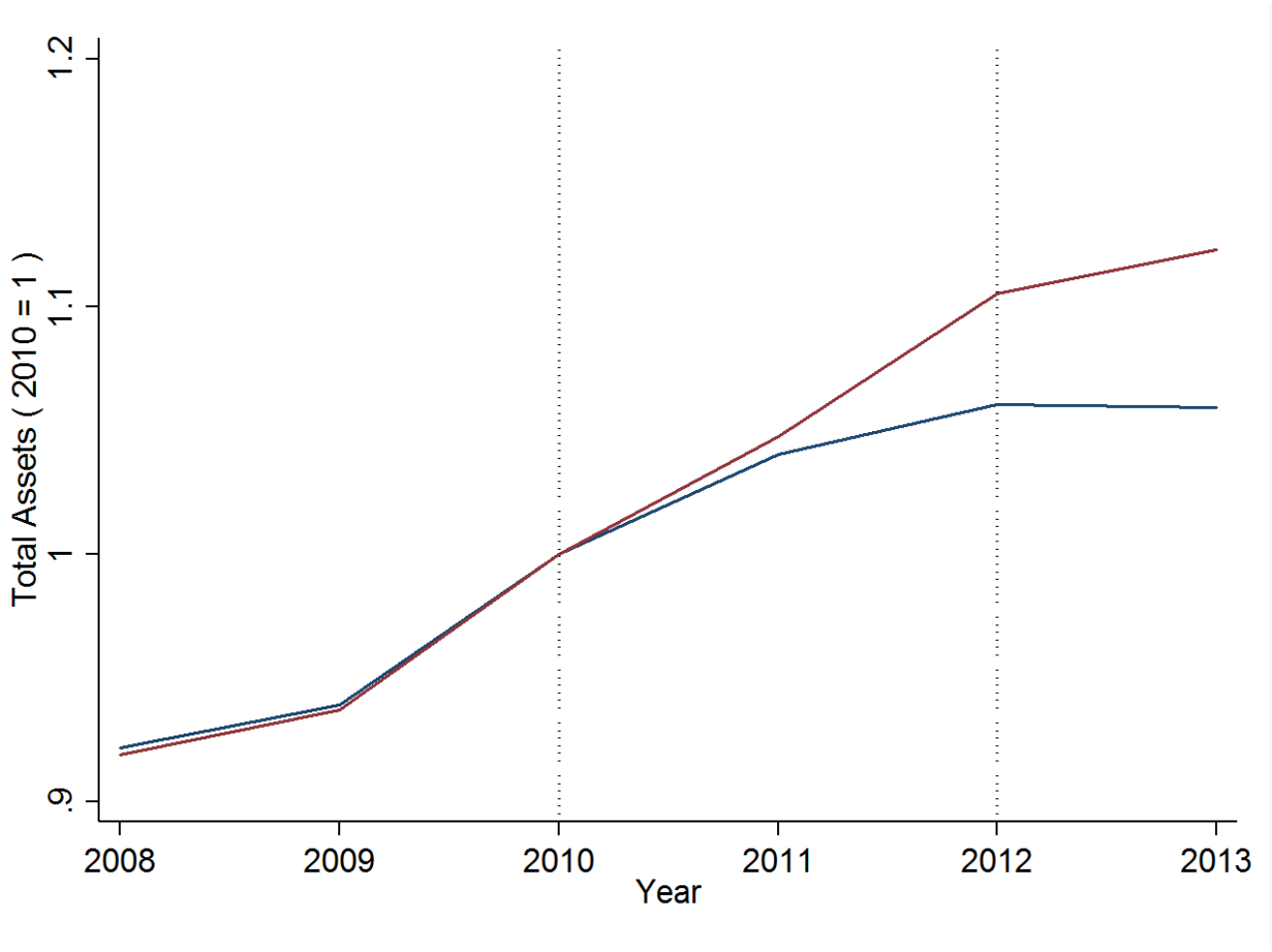

Figure 7. Firm Total Assets Over Time. This figure shows the evolution of the mean total assets for both 681 unlisted CEB-dependent firms (solid blue line) and 793 unlisted Non-CEB-dependent firms (solid red line) firms in the matched control group, normalized to the value of 1 for the year 2010. The two dashed vertical lines mark 2010 and 2012, the years immediately before and after the capital exercise.

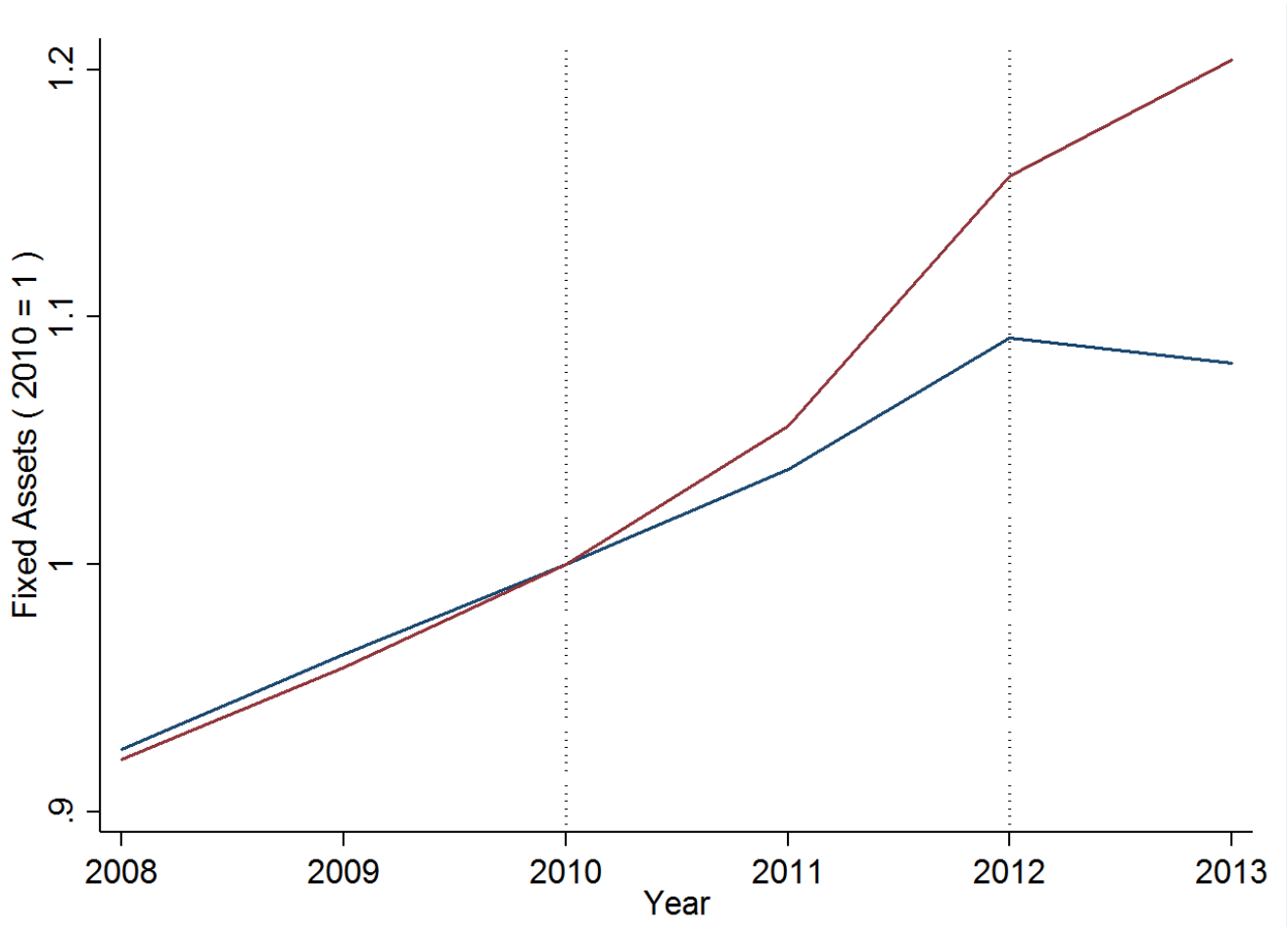

Figure 8. Firm Fixed Assets Over Time. This figure shows the evolution of the mean fixed assets for both 681 unlisted CEB-dependent firms (solid blue line) and 793 unlisted Non-CEB-dependent firms (solid red line) firms in the matched control group, normalized to the value of 1 for the year 2010. The two dashed vertical lines mark 2010 and 2012, the years immediately before and after the capital exercise.

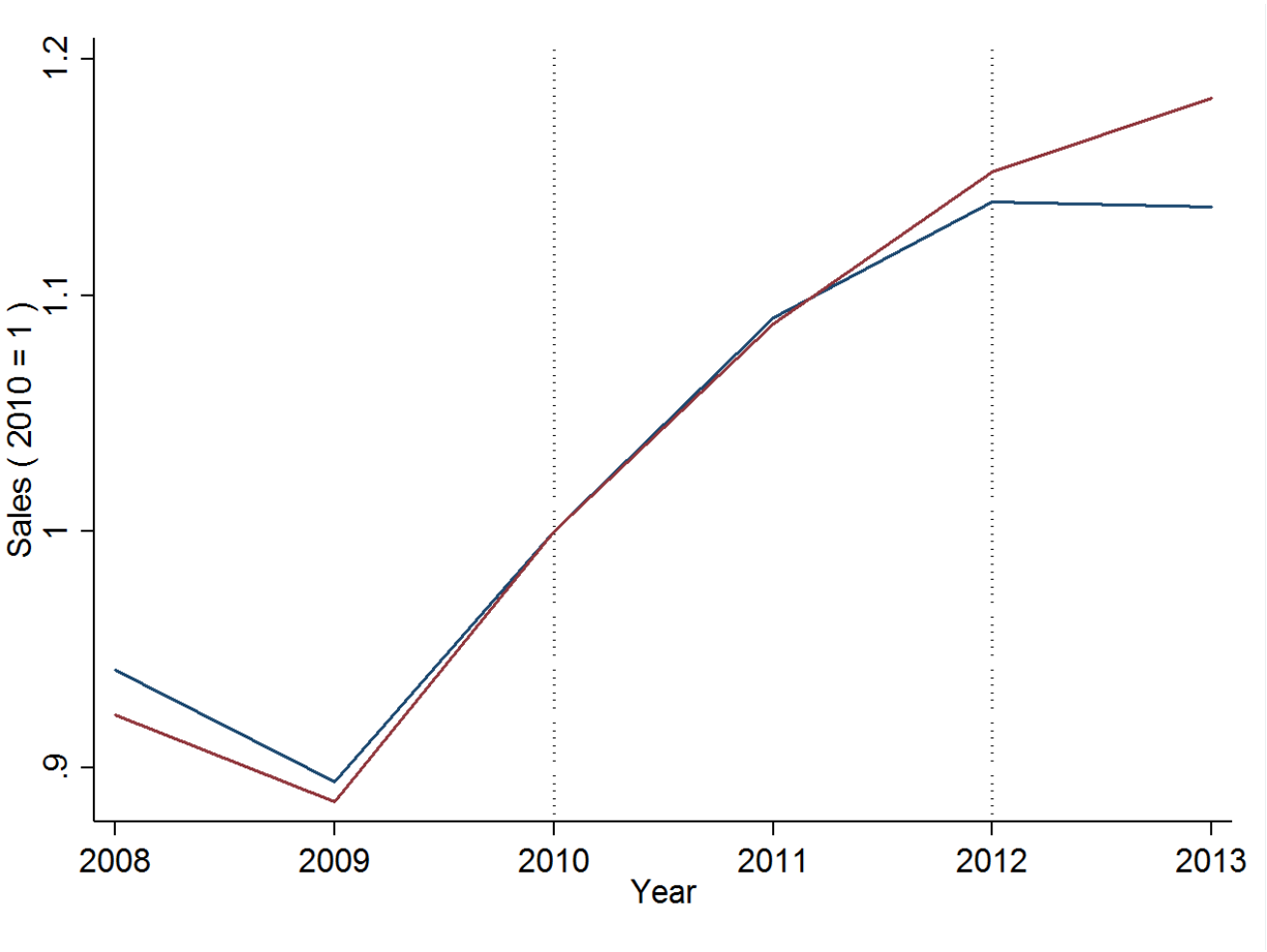

Figure 9. Firm Sales Over Time. This figure shows the evolution of the mean sales for both 681 unlisted CEB-dependent firms (solid blue line) and 793 unlisted Non-CEB-dependent firms (solid red line) firms in the matched control group, normalized to the value of 1 for the year 2010. The two dashed vertical lines mark 2010 and 2012, the years immediately before and after the capital exercise.

Table I
Matching Strategies

This table displays the four matching strategies employed in the paper. The *full sample* includes 48 Capital Exercise banks and 144 Non-Capital Exercise banks. The *overlap sample* includes all banks larger than the smallest Capital Exercise bank and smaller than the largest Non-Capital Exercise bank. The *threshold sample* includes the two smallest Capital Exercise banks and the two largest Non-Capital Exercise banks per country. The number of matches refers to the number of control group banks matched to each Capital Exercise bank. The matching covariate *Region* takes the value of 1 if the bank is headquartered in Greece, Ireland, Italy, Portugal or Spain, and 0 otherwise.

Matching Strategy	Full Sample	Overlap	Within Country	Within Region
Sample Used	Full Sample	Overlap	Threshold	Threshold
Number of Matches	1:4	1:1	1:2	1:4
Matching Covariates				
Total Assets	√	√	√	√
CT1 Capital Ratio	√		√	√
Total Deposits / Total Assets	√		√	√
Customer Loans / Total Assets	√		√	√
Net Int. Inc. / Op. Rev.	√		√	√
Net Income / Total Assets	√		√	√
Country			√	
Region				√

Table II
Summary Statistics

This table provides the summary statistics for all the dependent variables used in the paper. Panel A provides the summary statistics of the depended variables used in the bank-level part for the full sample (48 Capital Exercise banks and 144 Non-Capital Exercise banks), Panel B the summary statistics of the dependent variables used in the loan-level part and Panel C the summary statistics of the dependent variable used in the firm-level part.

Variable	Mean	Median	SD
Panel A: Variables Used in the Bank-Level Analysis			
ΔCT1 Ratio	1.82	1.95	2.60
ΔLog CT1 Capital	0.19	0.19	0.23
ΔLog Tier 1 Common Equity	0.17	0.18	0.26
ΔLog Retained Earnings	0.11	0.18	0.62
ΔLog Share Capital & Premium	0.23	0.10	0.48
Δ (Regulatory Adjustments / CT1 Capital)	-0.01	0.00	0.34
ΔLog RWA	0.02	0.01	0.23
ΔLog Credit RWA	0.00	-0.01	0.23
ΔLog Corporate Exposure	-0.16	-0.10	0.53
ΔLog Retail Exposure	-0.04	-0.02	0.37
ΔLog Sovereign Exposure	0.02	0.08	1.33
ΔLog Other Exposure	0.38	0.35	1.01
ΔLog Market RWA	-0.16	0.03	1.18
ΔLog Operational RWA	0.12	0.09	0.28
Δ (RWA / Total Assets)	-4.34	-2.74	8.66
Δ (Loan Loss Reserves / Customer Loans)	1.42	0.41	2.76
ΔLog Total Assets	0.11	0.09	0.21
ΔLog Customer Loans	0.10	0.09	0.26
ΔLog Total Securities	0.16	0.13	0.53
Panel B: Variables Used in the Loan-Level Analysis			
ΔLoan Exposure	-0.02	0.00	0.68
Exit	0.07	0.00	0.26
Entry	0.08	0.08	0.27
Panel C: Variables Used in the Firm-Level Analysis			
ΔLog Total Assets	0.10	0.07	0.34
ΔLog Fixed Assets	0.11	0.05	0.43
ΔLog Sales	0.14	0.13	0.49
Δ(Debt / Total Assets)	0.00	0.00	0.12
ΔLog Employees	0.04	0.03	0.42

Table III
Pre-Treatment Characteristics of Banks

This table provides pre-treatment summary statistics on Capital Exercise banks, Non-Capital Exercise banks and control group banks (mean comparison). The paper tests for differences in means using the Students t-test. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively. Panel A compares the mean values of the 48 Capital Exercise banks and 145 Non-Capital Exercise banks in the unmatched sample. Panel B compares the 48 Capital Exercise banks to the full sample of matched control group banks based on the Mahalanobis matching estimator. Panels C to E compare Capital Exercise banks to the sample of matched control group banks using the *overlap matching*, *within country matching* and *within region matching* strategies respectively. Table I lists the matching covariates for each matching

	# Banks	Total Assets	CT1 Ratio	Deposits / TA	Loans / TA	NII / Op. Rev.	Net Inc./ TA
Panel A: Unmatched Sample							
Capital Exercise Banks	48	454.31	9.86	40.93	56.73	60.42	0.39
Non-Capital Exercise Banks	144	24.43	11.41	55.54	66.62	67.69	0.41
Δ		429.87***	−1.55**	−14.61***	−9.89***	−7.27**	-0.02
Panel B: Full Sample Matching							
Capital Exercise Banks	48	454.31	9.86	40.93	56.73	60.42	0.39
Non-Capital Exercise Banks	76	107.14	10.30	47.89	64.80	64.62	0.41
Δ		347.17***	-0.44	−6.95***	−8.07***	−4.19***	-0.02
Panel C: Overlap Matching							
Capital Exercise Banks	36	161.32	9.98	41.97	59.78	61.95	0.40
Non-Capital Exercise Banks	16	156.10	10.95	53.80	57.06	71.89	0.38
Δ		5.22	-0.96	−11.83**	2.72	−9.94	0.02
Panel D: Within Country Matching							
Capital Exercise Banks	25	320.88	9.96	43.51	59.08	58.80	0.40
Non-Capital Exercise Banks	25	80.92	10.80	43.21	61.72	71.22	0.42
Δ		239.96***	−0.84*	0.31	-2.64	−12.42*	-0.02
Panel E: Within Region Matching							
Capital Exercise Banks	26	310.18	10.01	44.85	59.77	58.99	0.45
Non-Capital Exercise Banks	26	180.49	9.95	47.63	64.12	59.39	0.50
Δ		129.69*	0.07	-2.77	−4.35**	-0.40	-0.04

Table IV
Pre-Treatment Trends in Core Tier 1 Ratios

This table presents the mean change in investment for Capital Exercise banks and control group banks between 2010 and 2009, 2008 and 2007 respectively. The table reports p-values associated with test statistics for differences in means (standard t-test). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

	Panel A: Full Sample			*Panel B: Overlap*		
		Matched			Matched	
Variable	Treatment	Control	Δ	Treatment	Control	Δ
ΔCT1 Ratio (2010-2009)	0.53	0.56	-0.03	0.40	0.70	-0.30
ΔCT1 Ratio (2010-2008)	1.97	1.04	0.93***	1.76	1.73	0.02
ΔCT1 Ratio (2010-2007)	2.41	1.71	0.70*	2.22	2.65	-0.43
ΔLog CT1 Capital (2010-2009)	0.06	0.09	−0.03*	0.04	0.09	−0.05*
ΔLog CT1 Capital (2010-2008)	0.25	0.20	0.04	0.19	0.19	0.00
ΔLog CT1 Capital (2010-2007)	0.31	0.20	0.11***	0.28	0.24	0.04
ΔLog RWA (2010-2009)	0.01	0.03	-0.02	0.01	0.02	-0.01
ΔLog RWA (2010-2008)	0.02	0.09	−0.07**	-0.01	0.00	-0.01
ΔLog RWA (2010-2007)	0.00	0.02	-0.02	-0.01	-0.05	0.05
	Panel C: Within Country			*Panel D: Within Region*		
		Matched			Matched	
Variable	Treatment	Control	Δ	Treatment	Control	Δ
ΔCT1 Ratio (2010-2009)	0.66	0.68	-0.01	0.56	0.75	-0.19
ΔCT1 Ratio (2010-2008)	2.04	1.73	0.31	2.02	1.11	0.91*
ΔCT1 Ratio (2010-2007)	2.66	1.97	0.69	2.60	1.85	0.74
ΔLog CT1 Capital (2010-2009)	0.07	0.10	-0.03	0.06	0.12	−0.05**
ΔLog CT1 Capital (2010-2008)	0.28	0.23	0.05	0.28	0.22	0.07
ΔLog CT1 Capital (2010-2007)	0.34	0.27	0.07	0.35	0.28	0.07
ΔLog RWA (2010-2009)	0.00	0.03	-0.03	0.01	0.04	-0.02
ΔLog RWA (2010-2008)	0.05	0.04	0.01	0.05	0.08	-0.03
ΔLog RWA (2010-2007)	0.01	0.05	-0.04	0.03	0.06	-0.03

Table V
Adjustment of Core Tier 1 Ratios

This table presents the estimates of the change in core tier 1 ratios and its components around the 2011 EBA capital exercise. The dependent variables are the change in the core tier 1 ratio (ΔCT1 Ratio), the change in the logarithm of core tier 1 capital (ΔLog CT1 Capital) and the change in the logarithm of the risk-weighted assets (ΔLog RWA). The first row contains the difference in the outcome variable for Capital Exercise banks between the before (2009 and 2010) and the after (2012 and 2013) period, and the second row contains difference in the outcome variable for matched control group banks over the same period. The paper tests for differences-in-means using the Welch two-sample t-test. The third row contains the estimate for the average treatment effect on the treated (ATT) based on the bias-corrected Mahalanobis matching estimator (Abadie and Imbens, 2002). Panel A presents the results for the *full sample matching* strategy, Panel B the results for the *overlap matching* strategy, Panel C presents the results for the *within country matching* strategy and Panel D the results for the *within region matching* strategy. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Dependent Variable	ΔCT1 Ratio	ΔLog CT1 Capital	ΔLog RWA
	(1)	(2)	(3)
Panel A: Full Sample Matching			
Capital Exercise Banks: After - Before	3.02***	0.19***	−0.10***
Matched Control Group: After - Before	1.78***	0.19***	0.03
Bias-Corrected Matching Estimator (ATT)	1.86***	0.02	−0.16***
Number of observations	48	48	48
Panel B: Overlap Matching			
Capital Exercise Banks: After - Before	3.09***	0.18***	−0.11***
Matched Control Group: After - Before	2.40***	0.29***	0.08**
Bias-Corrected Matching Estimator (ATT)	0.72	−0.10	−0.19**
Number of observations	36	36	36
Panel C: Within Country Matching			
Capital Exercise Banks: After - Before	3.29***	0.17***	−0.12***
Matched Control Group: After - Before	2.34***	0.21***	0.01
Bias-Corrected Matching Estimator (ATT)	1.19**	−0.07*	−0.15***
Number of observations	25	25	25
Panel D: Within Region Matching			
Capital Exercise Banks: After - Before	3.16***	0.17***	−0.11***
Matched Control Group: After - Before	2.15***	0.25***	0.04
Bias-Corrected Matching Estimator (ATT)	1.01**	−0.06	−0.13**
Number of observations	26	26	26

Table VI
Adjustment of Core Tier 1 Capital Components

This table presents the estimates of the changes in the components of the core tier 1 capital. Core tier 1 capital consists of Tier 1 common equity and Regulatory Adjustments. The two most important subcomponents of Tier 1 common equity are the Share Capital and Premium. The first and second row in each panel contain the differences in the outcome variables between the before (2009 and 2010) and the after (2012 and 2013) period for Capital Exercise banks and control group banks respectively. We test for differences in means using the Welch two-sample t-test. The third row in each panel contains the estimates for the average treatment effect on the treated (ATT) based on the bias-corrected Mahalanobis matching estimator (Abadie and Imbens, 2002). We report the results for the *full samle matching* strategy and *overlap matching* strategy. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Dependent Variable	ΔLog Tier 1 Common Equity	ΔLog Retained Earnings	ΔLog Share Capital & Premium	Δ(Regulatory Adjustments/CT1 Capital)
Panel A: Full Sample Matching				
Capital Exercise Banks: After - Before	0.12^{***}	0.04	0.16	-0.09^{**}
Matched Control Group: After - Before	0.19^{***}	0.14^{***}	0.24^{***}	0.01
Bias-Corrected Matching Estimator (ATT)	−0.08	−0.11	−0.06	-0.11^{**}
Number of observations	48	45	43	48
Panel B: Overlap Matching				
Capital Exercise Banks: After - Before	0.13^{***}	0.05	0.16	−0.06
Matched Control Group: After - Before	0.29^{***}	0.14^{***}	0.43^{***}	0.00
Bias-Corrected Matching Estimator (ATT)	-0.16^{*}	−0.09	−0.26	−0.06
Number of observations	36	34	34	36

Table VII
Adjustment of Risk-Weighted Asset Components

This table presents the estimates of the changes in the components of the risk-weighted assets. Risk-weighted Assets consist of risk-weighted assets for credit risk, market risk, and operational risk. The first and second row in each panel contain the differences in the outcome variables between the before (2009 and 2010) and the after (2012 and 2013) period for Capital Exercise banks and control group banks respectively. We test for differences in means using the Welch two-sample t-test. The third row in each panel contains the estimates for the average treatment effect on the treated (ATT) based on the bias-corrected Mahalanobis matching estimator (Abadie and Imbens, 2002). We report the results for the *full samle matching* strategy and *overlap matching* strategy. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Dependent Variable	ΔLog Credit RWA	ΔLog Market RWA	ΔLog Operational RWA
Panel A: Full Sample Matching			
Capital Exercise Banks: After - Before	-0.13^{***}	-0.08	0.08^{*}
Matched Control Group: After - Before	-0.03^{***}	-0.29^{***}	0.09^{***}
Bias-Corrected Matching Estimator (ATT)	-0.20^{***}	0.02	0.04
Number of observations	48	46	47
Panel B: Overlap Matching			
Capital Exercise Banks: After - Before	-0.13^{***}	-0.24	0.07
Matched Control Group: After - Before	0.06^{*}	0.30^{***}	0.14^{***}
Bias-Corrected Matching Estimator (ATT)	-0.19^{**}	-0.54	-0.07
Number of observations	36	34	35

Table VIII
Adjustment of Credit Risk-Weighted Asset by Exposure Category

This table presents the estimates of the changes in the components of the risk-weighted assets. Risk-weighted Assets consist of risk-weighted assets for credit risk, market risk, and operational risk. The first and second row in each panel contain the differences in the outcome variables between the before (2009 and 2010) and the after (2012 and 2013) period for Capital Exercise banks and control group banks respectively. We test for differences in means using the Welch two-sample t-test. The third row in each panel contains the estimates for the average treatment effect on the treated (ATT) based on the bias-corrected Mahalanobis matching estimator (Abadie and Imbens, 2002). We report the results for the *full samle matching* strategy and *overlap matching* strategy. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Dependent Variable	ΔLog Corporate Exposures	ΔLog Retail Exposures	ΔLog Sovereign Exposures	ΔLog Other Exposures
Panel A: Full Sample Matching				
Capital Exercise Banks: After - Before	-0.23^{***}	-0.10^{*}	-0.04	0.15
Matched Control Group: After - Before	-0.02	0.10^{***}	-0.03	0.71^{***}
Bias-Corrected Matching Estimator (ATT)	-0.24^{**}	-0.34^{***}	0.88^{*}	0.20
Number of observations	47	47	40	47
Panel B: Overlap Matching				
Capital Exercise Banks: After - Before	-0.24^{***}	-0.08	-0.14	0.14
Matched Control Group: After - Before	0.38^{***}	0.19^{***}	0.12	0.46^{***}
Bias-Corrected Matching Estimator (ATT)	-0.63^{**}	-0.27	-0.24	-0.33
Number of observations	35	35	28	35

Table IX
Risk Reduction and Asset Shrinking

Columns 1 and 2 of this table present the estimates of the percentage point change in measures associated with risk reduction behavior. The dependent variables are the change in the ratio of risk-weighted assets over total assets Δ*(RWA/TA)* and the change in the ratio of loan loss reserves over total net customer loans Δ*(LLR/Cust. Loans)*. Columns 3 to 5 of this table present the estimates of the percentage change in measures associates with asset shrinking. The dependent variables are Δ*Log TA*, the change in the logarithm of total assets, Δ*Log Cust. Loans*, the change in the logarithm of total net customer loans and Δ*Log Total Securities*, the change in the logarithm of total securities. The first row in each panel contains the difference in the outcome variable for Capital Exercise banks between the before (2009 and 2010) and the after (2012 and 2013) period, and the second row in each panel contains difference in the outcome variable for matched control group banks over the same period. The paper tests for differences-in-means using the Welch two-sample t-test. The third row in each panel contains the estimate for the average treatment effect on the treated (ATT) based on the bias-adjusted Mahalanobis matching estimator (Abadie and Imbens, 2002). We report the results for the *full samle matching* strategy and *overlap matching* strategy. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

	Risk Reduction		Asset Shrinking		
Dependent Variable	Δ(RWA/TA)	Δ(LLR/Cust. Loans)	ΔLog TA	ΔLog Cust. Loans	ΔLog Total Securities
Panel A: Full Sample Matching					
Capital Exercise Banks: After - Before	-5.99^{***}	1.56^{***}	0.03	0.01	0.07
Matched Control Group: After - Before	-4.55^{***}	1.29^{***}	0.13^{***}	0.10^{***}	0.19^{***}
Bias-Corrected Matching Estimator (ATT)	-0.71	0.64	-0.14^{***}	-0.12^{***}	-0.17^{**}
Number of observations	48	48	48	48	48
Panel B: Overlap Matching					
Capital Exercise Banks: After - Before	-6.46^{***}	1.94^{***}	0.02	0.01	0.07
Matched Control Group: After - Before	-5.92^{***}	1.97^{***}	0.17^{***}	0.28^{***}	0.16^{*}
Bias-Corrected Matching Estimator (ATT)	-0.64	0.00	-0.15^{*}	-0.27^{**}	-0.09
Number of observations	36	36	36	36	36

Table X
Banks with High and Low Holdings of Subordinated Debt

This table presents the estimates of the change in core tier 1 ratios and its components around the 2011 EBA capital exercise for banks with high and low holdings of subordinated debt. The dependent variables are the change in the core tier 1 ratio (ΔCT1 Ratio), the change in the logarithm of core tier 1 capital (ΔLog CT1 Capital), and the change in the logarithm of the risk-weighted assets (ΔLog RWA). The first row contains the difference in the outcome variable for Capital Exercise banks between the before (2009 and 2010) and the after (2012 and 2013) period, and the second row contains difference in the outcome variable for matched control group banks over the same period. The paper tests for differences-in-means using the Welch two-sample t-test. The third row contains the estimate for the average treatment effect on the treated (ATT) based on the bias-adjusted Mahalanobis matching estimator (Abadie and Imbens, 2002). We report the results for the *full samle matching* strategy and *overlap matching* strategy. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

	Banks with Low Holdings of Subordinated Debt			
Dependent Variable	ΔCT1 Ratio	ΔLog CT1 Capital	ΔLog RWA	ΔLog Sub. Debt
Panel A: Full Sample Matching				
Capital Exercise Banks: After - Before	3.67***	0.25***	−0.08***	−0.24*
Matched Control Group: After - Before	2.11***	0.15***	−0.02	−0.06*
Bias-Corrected Matching Estimator (ATT)	2.75***	0.22***	0.00	0.10
Number of observations	26	26	26	26
Panel B: Overlap Matching				
Capital Exercise Banks: After - Before	3.99***	0.26***	−0.10***	−0.28*
Matched Control Group: After - Before	3.64***	0.17***	−0.06	−0.46***
Bias-Corrected Matching Estimator (ATT)	0.26	0.08	−0.03	0.18
Number of observations	20	20	20	20
	Banks with High Holdings of Subordinated Debt			
Panel C: Full Sample Matching				
Capital Exercise Banks: After - Before	2.25***	0.11***	−0.13***	−0.46**
Matched Control Group: After - Before	1.79***	0.23***	0.05**	−0.22***
Bias-Corrected Matching Estimator (ATT)	3.37**	−0.12	−0.59***	−0.51***
Number of observations	22	22	22	22
Panel D: Overlap Matching				
Capital Exercise Banks: After - Before	1.96**	0.09*	−0.13**	−0.53**
Matched Control Group: After - Before	2.29***	0.32***	0.09*	−0.26**
Bias-Corrected Matching Estimator (ATT)	−0.14	−0.22***	−0.23**	−0.31
Number of observations	16	16	16	16

Table XI
Syndicated Lending: Intensive Margin

Table XI presents the estimation results of the change in lending around the 2011 EBA capital exercise from Equation 1 in Section II:

$$\Delta\text{Log Loan Exposure}_{bij} = \beta \cdot \text{CEB}_{bi} + \gamma \cdot X_{bi} + \eta_j + \eta_i + \epsilon_{bij}$$

where Δ*Log Loan Exposure*$_{bij}$ is the change in loan exposure of bank b in country i to firm cluster j between the four quarters before the EBA capital exercise (2010Q3 - 2011Q2) and the four quarters after the capital exercise (2012Q3 - 2013Q2). The variable *CEB*$_{bi}$ takes on the value of 1 if the bank is a Capital Exercise bank, and 0 otherwise. Bank characteristics include: Log Total Assets, Core Tier 1 Ratio, Customer Loans / Total Assets, Net Interest Income / Operating Revenue, Total Deposits / Total Assets, and Net Income / Total Assets, all as of 2010. η_j are Borrower Home Country $\times$ Industry (firm cluster) fixed effects and η_i are bank home country fixed effects. The intensive margin sample includes country-industry firm clusters to which banks lend before and after the capital exercise. All quarterly data for a given firm cluster are collapsed to a single before and after period. Standard errors are clustered at the bank level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)
CEB	−0.09*	−0.14*	−0.16**	−0.16**	−0.17**
	(0.05)	(0.08)	(0.08)	(0.07)	(0.07)
Bank Home Country FE	YES	YES	YES	YES	YES
Bank Characteristics		YES	YES	YES	YES
Borrower Home Country FE			YES	YES	
Industry FE				YES	
Borrower Home Country × Industry FE					YES
Capital Exercise Banks	45	45	45	45	45
Control Group Banks	27	27	27	27	27
Adjusted R^2	0.02	0.03	0.07	0.09	0.25
Observations	2,177	2,177	2,177	2,177	2,177

Table XII
Pre-Treatment Characteristics of Firms

This table provides pre-treatment summary statistics on CEB-dependent firms, Non-CEB-dependent firms and control group firms (mean comparisons). CEB-dependent firms are firms dependent on funding from Capital Exercise banks in the syndicated loan market which obtain an above-median share of their borrowing from Capital Exercise banks in the pre-treatment period. Non-CEB dependent firms are firms are firms obtaining a below-median share of their borrowing from Capital Exercise banks. The paper tests for differences in means using Students t-test statistics. Panel A compares the mean values of 952 CEB-dependent firms and 1006 Non-CEB-dependent firms in the unmatched sample. Panel B compares the 952 CEB dependent firms to the sample of matched control group firms based on the Mahalanobis matching estimator. *, ** and *** indicated statistical significance at the 10%, 5%, and 1% level respectively.

	# Firms	Log Total Assets	Tangibility	Cash Flow / Total Assets	Net Worth	EBITDA / Total Assets	Leverage
Panel A: Unmatched Sample							
CEB-dependent Firms	952	19.78	0.59	0.07	0.24	0.09	0.92
Non-CEB-dependent Firms	1,006	19.48	0.56	0.07	0.25	0.09	0.91
Δ		0.30***	0.03***	0.00	-0.01	0.00	0.01**
Panel B: Matched Sample							
CEB-dependent Firms	952	19.78	0.59	0.07	0.24	0.09	0.92
Non-CEB-dependent Firms	952	19.80	0.59	0.07	0.24	0.10	0.92
Δ		−0.02	0.00*	0.00	0.00	0.00	0.00

Table XIII
Firm-Level Outcomes

This table presents the estimates of the change in different firm-level outcomes around the 2011 EBA capital exercise. The dependent variables are the change in the logarithms of total assets, fixed assets and sales, the change in the debt-to-asset ratio, and the change in the logarithm of employment. The first row in each Panel contains the differences in the outcome variables for Capital Exercise Bank (CEB) dependent firms between the before (2009 and 2010) and the after (2012 and 2013) period, and the second row contains the differences in the outcome variables for matched control group firms over the same period. The paper tests for those differences-in-means using a one-sample t-test. The third row contains the estimate for the average treatment effect on the treated (ATT) based on the bias-corrected Mahalanobis matching estimator Abadie and Imbens (2002). Panel A presents the results for all firms in our sample, Panel B the results for unlisted firms in our sample, and Panel C the results for listed firms in our sample. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Dependent Variable	ΔLog Total Assets	ΔLog Fixed Assets	ΔLog Sales	Δ(Total Debt/TA)	ΔLog Employment
	(1)	(2)	(3)	(4)	(5)
Panel A: All Firms					
CEB-Dependent Firms: After - Before	0.07***	0.07***	0.12***	0.02	0.02
Non-CEB-Dependent Firms: After - Before	0.10***	0.10***	0.14***	0.00	0.03
Bias-Corrected Matching Estimator (ATT)	−0.04**	−0.06***	−0.05**	0.00	-0.02
Number of Observations	952	952	952	952	796
Panel B: Unlisted Firms					
CEB-Dependent Firms: After - Before	0.04**	0.05*	0.14***	0.04	0.05
Non-CEB-Dependent Firms: After - Before	0.10***	0.11***	0.06*	0.01	0.07**
Bias-Corrected Matching Estimator (ATT)	−0.06***	−0.09***	−0.04	0.00	-0.01
Number of Observations	681	681	681	681	544
Panel C: Listed Firms					
CEB-Dependent Firms: After - Before	0.13***	0.13***	0.04	-0.01	-0.06
Non-CEB-Dependent Firms: After - Before	0.10***	0.08***	0.21***	0.01	−0.07*
Bias-Corrected Matching Estimator (ATT)	0.02	0.03	−0.06	-0.01	-0.01
Number of Observations	271	271	271	271	251

Table XIV
Placebo Test: Changes in Core Tier 1 Ratios between 2009-2010

This table presents the estimates of the change in core tier 1 ratios and ist components over the placebo period from 2009 to 2010. The dependent variables are the change in the core tier 1 ratio, the change in the logarithm of core tier 1 capital, and the change in the logarithm of risk-weighted assets. The first row contains the difference in the outcome variable for Capital Exercise banks between the before (2009) and the after (2010) placebo period, and the second row contains the difference in the outcome variable for matched control group banks over the same period. The paper tests for those difference-in-means using a one-sample t-test. The third row contains the estimate of the average treatment effect on the treated (ATT) based on the bias-adjusted Mahalanobis matching estimator Abadie and Imbens (2002). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Dependent Variable	ΔCT1 Ratio	ΔLog CT1 Capital	ΔLog RWA
	(1)	(2)	(3)
Capital Exercise Banks: After - Before	0.53	0.06^{***}	0.01
Matched Control Group: After - Before	0.55	0.09^{***}	0.03^{**}
Bias-Corrected Matching Estimator (ATT)	0.13	-0.03	-0.06^{*}
Number of Observations	48	48	48

Table XV
Weakly and Strongly Capitalized Banks

This table presents the estimates of the change in core tier 1 ratios and its components around the 2011 EBA capital exercise for the subsample of weakly (Panel A) and strongly (Panel B) capitalized banks. Banks are defined as weakly (strongly) capitalized if they exhibit a core tier 1 ratio below (above) 9% as of end of 2010 prior to the capital exercise. The dependent variables are the change in the core tier 1 ratio, the change in the logarithm of core tier 1 capital and the change in the logarithm of the risk-weighted assets. The first row contains the difference in the outcome variable for Capital Exercise banks between the before (2009) and 2010) and the after (2012 and 2013) period, and the second row contains difference in the outcome variable for matched control group banks over the same period. The paper tests for differences-in-means using the Welch two-sample t-test. The third row contains the estimate of the average treatment effect on the treated (ATT) based on the bias-adjusted Mahalanobis matching estimator Abadie and Imbens (2002). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Dependent Variable	ΔCT1 Ratio	ΔLog CT1	ΔLog RWA
	(1)	(2)	(3)
Panel A: Weakly Capitalized Banks			
Capital Exercise Banks: After - Before	3.75***	0.21***	−0.18***
Matched Control Group: After - Before	1.72***	0.20***	0.02
Bias-Corrected Matching Estimator (ATT)	−0.09	−0.98***	−1.02***
Number of Observations	22	22	22
Panel B: Strongly Capitalized Banks			
Capital Exercise Banks: After - Before	2.40***	0.16***	−0.04*
Matched Control Group: After - Before	2.10***	0.20***	0.03*
Bias-Corrected Matching Estimator (ATT)	1.24*	0.02	−0.10**
Number of Observations	26	26	26

Table XVI
Syndicated Lending: Extensive Margin

This table presents the estimation results of whether banks started or stopped lending to country-industry firm clusters around the 2011 EBA capital exercise from Equation 3 in Section IV:

$$Y_{bij} = \alpha + \beta \cdot \text{CEB}_{bi} + \gamma X_{bi} + \eta_i + \eta_j + \epsilon_{bij} \tag{6}$$

$$\tag{7}$$

where Y_{bij} is either the dummy variable $Exit_{bij}$, which takes on the value of 1 if bank b from country i stopped lending to firm cluster j after the capital exercise, and 0 otherwise; or the dummy variable $Entry_{bij}$, which takes on the value of 1 if bank b from country i started lending to firm cluster j after the capital exercise, and 0 otherwise. The variable CEB_{bi} takes on the value of 1 if the bank is part of the EBA capital exercise, and 0 otherwise. η_j are Borrower Home Country $\times$ Industry (firm cluster) fixed effects and η_i are bank home country fixed effects. Bank characteristics include: Total Assets, CT1 Capital Ratio, Total Deposits / TA, Customer Loans / TA, Net Interest, Income / Operating Revenue, and Net Income / TA, measured in the before period. Standard errors are clustered at the bank level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Dependent Variable	Exit			Entry		
	(1)	(2)	(3)	(4)	(5)	(6)
CEB	−0.01	0.05*	0.04	−0.07***	−0.05*	−0.03
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.02)
Bank Home Country FE	YES	YES	YES	YES	YES	YES
Bank Characteristics		YES	YES		YES	YES
Borrower Country x Industry FE			YES			YES
Capital Exercise Banks	45	45	45	45	45	45
Control Group Banks	45	45	45	50	50	50
Adjusted R^2	0.02	0.02	0.25	0.06	0.06	0.28
Observations	2,344	2,344	2,344	2,345	2,345	2,345

For Online Publication

Online Appendix for

"Bank Response To Higher Capital Requirements: Evidence From A Quasi-Natural Experiment"

November 2017

Table A1
List of Banks in the 2011 EBA Capital Exercise

This table lists all 61 banks initially included in the 2011 EBA capital exercise. As the paper wants to track the behavior of independent banks over time, we also exclude all banks which were acquired during the sample period, all banks which received capital injections during the pre-treatment period and all banks with negative levels of equity. This sample construction procedure finally leaves us with a sample of 48 EBA banks.

Bank	Country	Sample
Erste Group Bank AG	Austria	✓
Raiffeisen Bank International AG	Austria	✓
KBC Bank NV	Belgium	
Bank of Cyprus Public Company Limited	Cyprus	
Cyprus Popular Bank Public Co. Ltd.	Cyprus	
Danske Bank A/S	Denmark	✓
Jyske Bank A/S	Denmark	✓
Nykredit Realkredit A/S	Denmark	✓
Sydbank A/S	Denmark	✓
OP Financial Group	Finland	✓
BNP Paribas SA	France	✓
Crédit Agricole Group	France	✓
Groupe BPCE	France	✓
Société Générale SA	France	✓
Bayerische Landesbank	Germany	
Commerzbank AG	Germany	
DekaBank Deutsche Girozentrale	Germany	✓
Deutsche Bank AG	Germany	✓
Deutsche Zentral-Genossenschaftsbank AG	Germany	✓
HSH Nordbank AG	Germany	
Hypo Real Estate Holding AG	Germany	
Landesbank Baden-Württemberg	Germany	
Landesbank Berlin Holding AG	Germany	✓
Landesbank Hessen-Thüringen Girozentrale	Germany	✓
NORD/LB Norddeutsche Landesbank Girozentrale	Germany	✓
Westdeutsche Genossenschafts-Zentralbank AG	Germany	✓
Allied Irish Banks, Plc	Ireland	
Bank of Ireland	Ireland	
Permanent TSB Group Holdings Plc	Ireland	✓

Table A1 (cont.)

Banca Monte dei Paschi di Siena SpA	Italy	✓
Banco Popolare Societ Cooperativa	Italy	✓
Intesa Sanpaolo SpA	Italy	✓
UniCredit SpA	Italy	✓
Unione di Banche Italiane SCpA	Italy	✓
OTP Bank Nyrt.	Hungary	✓
Banque et Caisse d'Epargne de l'Etat	Luxembourg	✓
Bank of Valletta Plc	Malta	✓
ABN AMRO Group NV	Netherlands	
ING Bank NV	Netherlands	
Rabobank Group	Netherlands	✓
SNS Bank NV	Netherlands	✓
DNB Bank ASA	Norway	✓
Powszechna Kasa Oszczednosci Bank Polski SA	Poland	✓
Banco BPI SA	Portugal	✓
Banco Comercial Portugus SA	Portugal	✓
Caixa Geral de Depsitos SA	Portugal	✓
Espirito Santo Financial Group SA	Portugal	✓
Nova Kreditna banka Maribor d.d.	Slovenia	✓
Nova Ljubljanska Banka d.d.	Slovenia	✓
Banco Bilbao Vizcaya Argentaria, SA	Spain	✓
Banco Popular Español SA	Spain	✓
Banco Santander SA	Spain	✓
La Caixa	Spain	✓
Nordea Bank AB	Sweden	✓
Skandinaviska Enskilda Banken AB	Sweden	✓
Svenska Handelsbanken AB	Sweden	✓
Swedbank AB	Sweden	✓
Barclays Plc	United Kingdom	✓
HSBC Holdings Plc	United Kingdom	✓
Lloyds Banking Group Plc	United Kingdom	✓
Royal Bank of Scotland Group Plc	United Kingdom	

Table A2
Variable Definitions

This table describes all variables used in the paper. All bank-level variables in Panel A are obtained from the SNL Financial database, all loan-level variables in Panel B are constructed from data obtained from the Thomson Reuters LPCs Dealscan databse, and all firm-level variables in Panel C are obtained from Bureau van Dijk's Amadeus Financials database.

Variable	**Definition**
Panel A: Bank-Level Analysis	
Core Tier 1 Capital Ratio (CT1 Ratio)	Core Tier 1 Capital / Risk-Weighted Assets
Log Core Tier 1 Capital	Natural Logarithm of Core Tier 1 Capital
Log RWA	Natural Logarithm of Risk-Weighted Assets
Log Total Assets	Natural Logarithm of Total Assets
Deposits / TA	Total Deposits / Total Assets
Loans / TA	Customer Loans / Total Assets
NII / Op. Rev.	Net Interest Income / Operating Revenue
Net Inc. / TA	Net Income / Total Assets
Panel B: Loan-Level Analysis	
ΔLoan Exposure	Natural logarithm of the change in the loan exposure of bank b in country i to firm cluster j between the period before (2010Q3-2011Q2)
Entry	= 1 if bank b in country i starts lending to firm cluster j after the EBA capital exercise, and 0 otherwise
Exit	= 1 if bank b in country i stops lending to firm cluster j after the EBA capital exercise, and 0 otherwise
Panel C: Firm-Level Analysis	
Log Total Assets	Natural Logarithm of Total Assets
Log Fixed Assets	Natural Logarithm of Fixed Assets
Log Sales	Natural Logarithm of Firm Sales
Tangibility	Fixed Assets / Total Assets
Cash Flow/TA	Cash Flow / Total Assets
Net Worth	$\frac{\text{Total Shareholder Funds \& Liabilities - Current\&Non-Current Liabilities-Cash}}{\text{Total Assets}}$
EBITDA/TA	EBITDA/ Total Assets
Leverage	$\frac{\text{Total Assets - Total Shareholder Funds: Capital}}{\text{Total Assets}}$

Table A3
Components of Risk-Weighted Assets and Regulatory Capital

This tabke shows the composition of regulatory capital and risk-weighted assets (RWA) according to the Basel 2 regulation. Risk-weighted assets consist of risk-weighted assets for credit risk, market risk and operational risk. Credit Risk RWA's include risk-weighted assets for, by Basel 2 defined, credit exposure classes, securitization exposures, and equity exposures. Sovereign exposures include all exposures to counterparties treated as sovereigns. Corporate exposures are debt obligations of a corporation, partnership or proprietorship (excl. SME exposures). Retail exposures are exposures to individuals, residential mortgage loans, loans extended to SMEs. Other exposures include all other exposures to credit risk (Claims on non-central government public sector entities (PSEs), multilateral development banks (MDBs), banks, securities firms, past due loans, higher-risk categories, equity exposures and off-balance sheet items) (BIS, 2005). Core Tier 1 Capital consists of Tier 1 Common Equity minus Regulatory adjustments. Tier 1 Common Equity includes the share capital, share premium, retained earnings and other items, like minority interests. Regulatory adjustments that are deducted from Tier 1 Common Equity are for example goodwill, deferred tax assets, and unrealized gains on securities held for sale. Tier 1 Common Equity is not the same as IFRS common equity. For example, it includes some assets which are eligible for core tier 1 capital, but not common equity (some forms of preferred equity and hybrid securities). To avoid confusion between IFRS capital and regulatory we use Tier 1 Common Equity and Regulatory Adjustments, which sum up to Core Tier 1 Capital, our main dependent variable.

	Risk-Weighted Assets		**Regulatory Capital**
	RWA for Corporate Exposures		Share Capital & Share Premium
+	RWA for Retail Exposures	+	Retained Earnings
+	RWA for Sovereign Exposures	+	Other Components
+	RWA for Other Exposures		
=	RWA for Credit Risk	=	Tier 1 Common Equity
+	RWA for Market Risk	+	Regulatory Adjustments
+	RWA for Operational Risk		
=	Total Risk-Weighted Assets	=	Core Tier 1 Capital

Table A4
Bank-Level Difference-in-Differences Regression Analysis

This appendix presents the estimation results of the following difference-in-difference regression:

$$Y_{ic} = \alpha + \beta \cdot \text{CEB}_{ic} + \gamma X_i + \eta_c + \epsilon_{ic}$$

where Y_{ic} is the change in the outcome variable of bank i in country c. The variable CEB_{ic} takes on the value 1 for the 48 Capital Exercise banks and 0 for the 144 non-Capital Exercise banks in our full sample. The dependent variables are the change in the core tier 1 ratio, the change in the logarithm of core tier 1 capital, and the change in the logarithm of risk-weighted assets between the before (2009) and 2010) and the after (2012 and 2013) period. Control variables are Total Assets, CT1 Capital Ratio, Total Deposits / TA, Customer Loans / TA, Net Interest Income / Operating Revenue, and Net Income / TA, measured in the before period. Standard errors are clustered at the country level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Panel A: Replication Table V

Dependent Variable	ΔCT1 Ratio			ΔLog CT1 Capital			ΔLog RWA		
CEB	1.60***	1.07**	1.40***	0.00	0.01	0.05	−0.16***	−0.11**	−0.10
	(0.43)	(0.51)	(0.47)	(0.04)	(0.04)	(0.06)	(0.04)	(0.04)	(0.06)
Bank Characteristics		YES	YES		YES	YES		YES	YES
Bank Home Country FE			YES			YES			YES
Number of Observations	192	192	192	192	192	192	192	192	192
R^2	0.07	0.21	0.40	0.00	0.07	0.30	0.10	0.25	0.45

Table A4 (cont.)

Panel B: Replication Table VI

Dependent Variable	ΔLog T1 Common Equity			ΔLog Retained Earnings			ΔLog Share Cap. & Prem.		
CEB	−0.07	−0.04	−0.01	−0.08	−0.12	−0.09	−0.10	−0.04	−0.14
	(0.05)	(0.05)	(0.08)	(0.14)	(0.14)	(0.17)	(0.13)	(0.14)	(0.16)
Bank Characteristics		YES	YES		YES	YES		YES	YES
Bank Home Country FE			YES			YES			YES
Number of Observations	187	187	187	185	185	185	162	162	162
R^2	0.01	0.08	0.31	0.00	0.06	0.43	0.01	0.03	0.12

Dependent Variable	Δ(Regulatory Adj./CT1 Capital)		
CEB	−0.10	−0.06	−0.05
	(0.06)	(0.05)	(0.08)
Bank Characteristics		YES	YES
Bank Home Country FE			YES
Number of Observations	187	187	187
R^2	0.02	0.03	0.12

Table A4 (cont.)

Dependent Variable	ΔLog Credit RWA			ΔLog Market RWA			ΔLog Operational RWA		
CEB	-0.18^{***}	-0.12^{***}	-0.12^{*}	0.11	0.21	0.09	−0.06	−0.05	−0.00
	(0.04)	(0.03)	(0.06)	(0.25)	(0.31)	(0.34)	(0.04)	(0.03)	(0.04)
Bank Characteristics		YES	YES		YES	YES		YES	YES
Bank Home Country FE			YES			YES			YES
Number of Observations	185	185	185	145	145	145	183	183	183
R^2	0.11	0.25	0.46	0.00	0.03	0.39	0.01	0.07	0.24

Panel D: Replication Table VIII

Dependent Variable	ΔLog Corporate Exposures			ΔLog Retail Exposures			ΔLog Other Exposures		
CEB	−0.15	-0.19^{*}	−0.06	-0.15^{**}	−0.14	-0.34^{***}	-0.69^{**}	-0.34^{**}	-0.46^{***}
	(0.12)	(0.11)	(0.15)	(0.07)	(0.08)	(0.10)	(0.25)	(0.15)	(0.14)
Bank Characteristics		YES	YES		YES	YES		YES	YES
Bank Home Country FE			YES			YES			YES
Number of Observations	85	85	85	85	85	85	84	84	84
R^2	0.02	0.15	0.33	0.04	0.12	0.35	0.12	0.41	0.65

Table A4 (cont.)

Panel C: Replication Table IX

Dependent Variable	Δ(RWA/TA)			Δ(LLR/Customer Loans)		
CEB	−2.21	−0.70	−2.30	0.20	0.59	−0.27
	(1.32)	(1.62)	(1.70)	(0.64)	(0.64)	(0.48)
Bank Characteristics		YES	YES		YES	YES
Bank Home Country FE			YES			YES
Number of Observations	192	192	192	163	163	163
R^2	0.01	0.12	0.35	0.00	0.12	0.67

Dependent Variable	ΔLog Total Assets			ΔLog Customer Loans			ΔLog Total Securities		
CEB	−0.11**	−0.11**	−0.07	−0.12***	−0.13***	−0.10**	−0.12	−0.20	−0.07
	(0.04)	(0.05)	(0.05)	(0.04)	(0.03)	(0.04)	(0.11)	(0.13)	(0.11)
Bank Characteristics		YES	YES		YES	YES		YES	YES
Bank Home Country FE			YES			YES			YES
Number of Observations	192	192	192	192	192	192	192	192	192
R^2	0.05	0.16	0.45	0.04	0.22	0.51	0.01	0.17	0.47

Regression Discontinuity Design

The empirical setting of the capital exercise seems to lend itself to a regression discontinuity (RD) design. Given the EBA's explicit selection rule based on bank size, the running variable is defined as bank size as a fraction of the country-specific size cutoff for being included in the capital exercise. The RD approach then exploits the country-specific selection threshold by comparing the change in core tier 1 ratios for banks just above and just below the threshold. Figure A1 shows the bank size distribution in each country normalized by the country-specific cutoff.

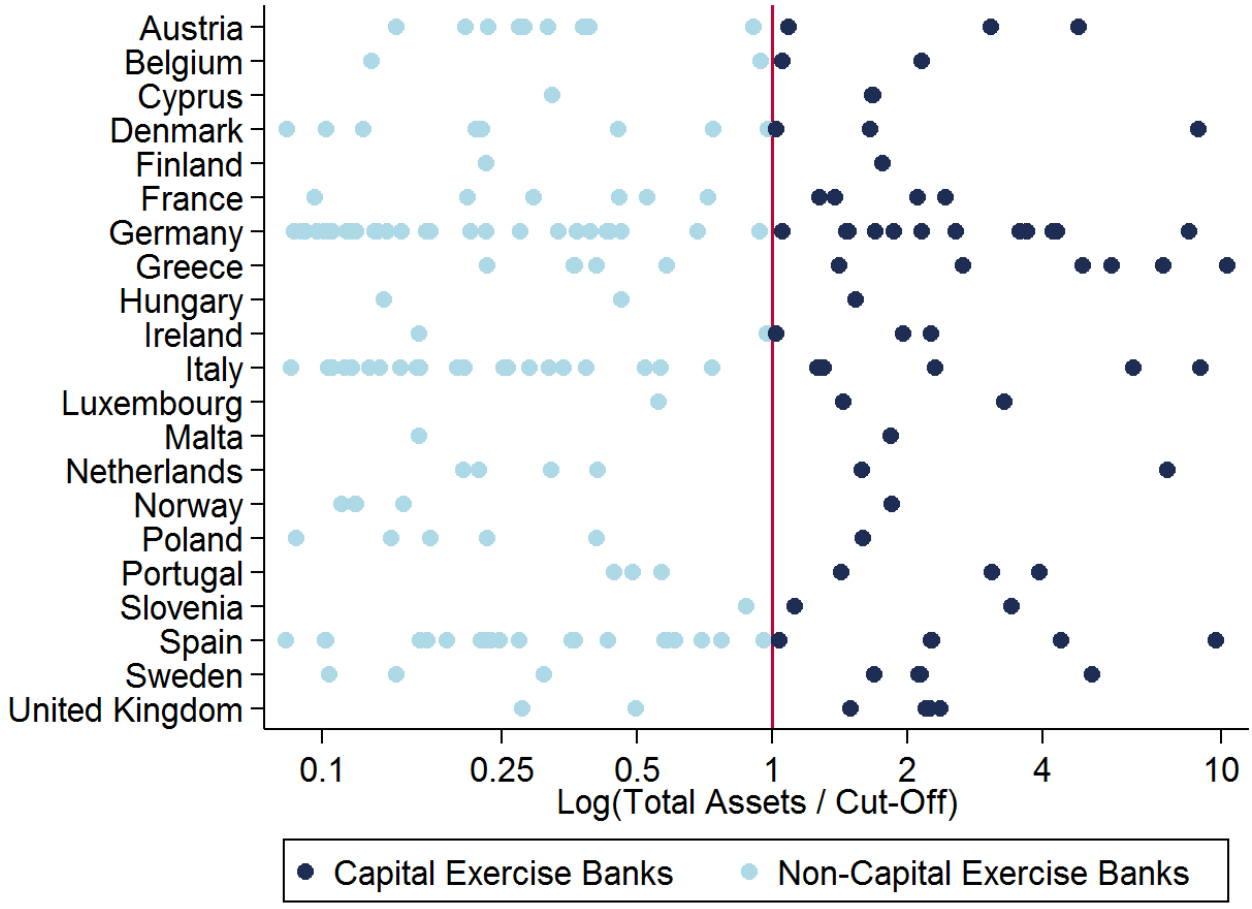

Figure A1. Distance from the Cutoff. This figure shows the bank size distribution normalized by the country specific selection cutoff (total assets as of end of 2010 / country specific cutoff) of Capital Exercise banks and Non-Capital Exercise banks by country. The graph includes all ultimate parent banks headquartered in EBA supervised countries included in the SNL database.

In some countries (for example Belgium, Denmark, Ireland, and Spain), the smallest Capital Exercise bank and largest Non-Capital Exercise bank have a similar size. In other countries (for example the Netherlands), this distance is bigger. The internal validity of an RD approach relies on two identifying assumptions: That banks could not manipulate the running variable and therefore whether they are included in the capital exercise or not; and that other bank characteristics affecting the outcome variables are continuous around the cutoff. Since the EBA capital exercise came unexpected in October 2011 and since selection into the exercise was based on banks' total assets as of end of 2010, it is unlikely that banks could manipulate their inclusion in the capital exercise. We test for manipulation using the procedure proposed in Cattaneo, Jansson, and Ma (2017). The results reject the manipulation hypothesis. Assessing the continuity of other bank characteristics around the cutoff requires the choice of a bandwidth, that is a definition of what it means to be "just above or just below the cutoff". Bandwidth selection is an important decision in the implementation of an RD design. For our analysis, we use the optimal bandwidth selection procedure by Calonico, Cattaneo, and Titiunik (2014). Figure A2 plots six bank characteristics (Log Total Assets, CT1 Capital Ratio, Total Loans/Total Assets, Net Interest Income/Operating Revenue, Total Deposits/Total Assets, Net Income / Total Assets) against the running variable, defined as bank size as a fraction of the country-specific size cutoff. The solid vertical lines indicate the threshold for being included in the Capital Exercise and the two dashed vertical lines indicate the optimal bandwidth based on Calonico, Cattaneo, and Titiunik (2014), which results in a sample of 22 banks around the cutoff. The figure shows that the bank characteristics do not clearly jump around the threshold, but also that there is a large variation in bank characteristics close to the threshold. The small number of observations, combined with large variation in bank characteristics around the cutoff, makes inference based on an RD design problematic in our setting. Table A5 presents the results for the RD approach. Panel A and Panel B use the full sample of banks and include a first-order polynomial and second-order polynomial in the running variable, respectively. We find results very similar to our matching methodology. Panel C then successively reduces the bandwidth. As discussed above, using the optimal bandwidth based on Calonico, Cattaneo, and Titiunik (2014) results in a sample of 22 banks. While the findings point in the same direction as our matching results, coefficients and standard errors become very large in magnitude, and the results are thus of limited informativeness.

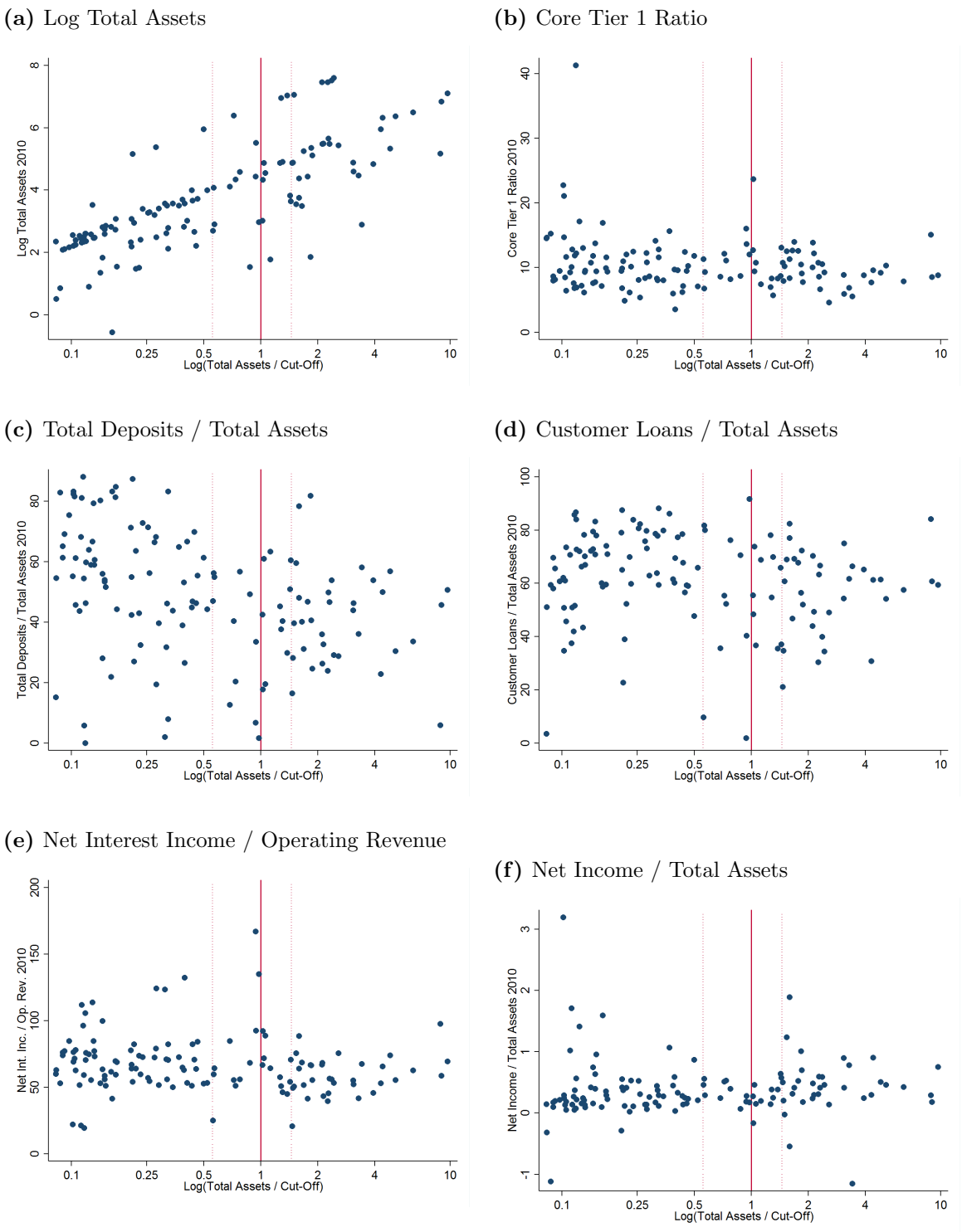

Figure A2. Bank Characteristics around the Cutoff. This figure shows the bank characteristics as a function of the distance to the cutoff (total assets / country specific cutoff). The red dotted line indicate the optimal bandwidth, estimated with the procedure developed by Calonico, Cattaneo, and Titiunik (2014).

Table A5
Regression Discontinuity Results

This table estimates the effect of higher capital requirements on the change in the core tier 1 ratio using a regression discontinuity approach. The sample is based on all Capital Exercise banks (48) and control group banks (144). The dependent variable is the change in the core tier 1 ratio, the change in the logarithm of core tier 1 capital and the change in the logarithm of the risk-weighted assets. The variable *Capital Exercise Bank* takes on the value of 1 Capital Exercise Bankif the bank size in total assets is larger than the country specific cutoff, and 0 otherwise. Standard errors are robust and clustered at the country level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Panel A: First-Order Polynomials									
Dependent Variable	ΔCT1 Ratio			ΔLog CT1 Capital			ΔLog RWA		
Capital Exercise Bank	1.71***	1.07*	1.45***	.0.05	−0.05	0.01	−0.21***	−0.16***	−0.13*
	(0.55)	(0.56)	(0.46)	(0.05)	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)
First Order Polynomial	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank Characteristics		YES	YES		YES	YES		YES	YES
Country FE			YES			YES			YES
Observations	192	192	192	192	192	192	192	192	192
R^2	0.08	0.20	0.38	0.02	0.08	0.31	0.11	0.23	0.42
Panel B: Second-Order Polynomials									
Capital Exercise Bank	1.72*	1.04	1.80***	−0.05	−0.04	0.03	−0.21***	−0.14***	−0.11
	(0.86)	(0.85)	(0.47)	(0.08)	(0.09)	(0.09)	(0.05)	(0.06)	(0.08)
First Order Polynomial	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank Characteristics		YES	YES		YES	YES		YES	YES
Country FE			YES			YES			YES
Observations	192	192	192	192	192	192	192	192	192
R^2	0.08	0.21	0.38	0.02	0.08	0.31	0.12	0.23	0.42

Table XVIII (cont.)

Panel C: Different Bandwiths

Dependent Variable	ΔCT1 Ratio			ΔLog CT1 Capital			ΔLog RWA		
Bandwith	$[-\infty;+\infty]$	[0.25;4.00]	[0.54;1.46]	$[-\infty;+\infty]$	[0.25;4.00]	[0.54;1.46]	$[-\infty;+\infty]$	[0.25;4.00]	[0.54;1.46]
Capital Exercise Bank	1.45***	1.07	12.75	0.01	−0.16	−5.60	−0.13*	−0.20	−6.69*
	(0.45)	(2.43)	(58.65)	(0.06)	(0.21)	(5.52)	(0.06)	(0.25)	(3.35)
First Order Polynomial	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank Characteristics	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	192	72	22	192	72	22	192	72	22
R^2	0.38	0.65	0.88	0.31	0.56	0.86	0.42	0.54	0.84

Stock Price and Bond Price Event Studies

If investors interpret a bank's decision to issue equity as a signal that the bank's stock is overvalued, then banks might want to avoid sending out such a negative signal. We therefore conduct event studies on banks' stock and bond prices around the announcement dates of seasoned equity offerings. For the stock price event studies, we collect data on the announcement dates of common equity issuances of Capital Exercise and Non-Capital Exercise banks from the SNL Capital Issuance Database. Furthermore, we collect data on banks' stock prices and on the *MSCI Europe Financials Index*, which we use as a market proxy.[27] We then calculate the cumulative abnormal stock returns around 79 seasoned equity offerings of Capital Exercise Banks (47) and Control Group Banks (32) during the sample period from 2009 and 2013. During the period of the capital exercise from 2011-Q3 to 2012-Q2, there were 7 equity issuances from Capital Exercise banks and 6 from banks in the matched control group. Panel A of Table A6 reports the results of the stock price event study for different time windows. We find some evidence for negative announcement effects over the whole sample period, but little evidence for negative announcement effects for equity issuances which took place during the period of the Capital Exercise, especially for equity issuances from Capital Exercise banks. The absence of negative announcement effects for Capital Exercise banks could be due to the fact that investors are presumably aware that banks are required to increase their capital ratios by the EBA, which possibly reduces the negative signaling effect of an equity issuance. However, it is difficult to draw a strong conclusion from this analysis, since seasoned equity issuances in the wake of the Capital Exercise were rare. For the bond price event study, we follow Bessembinder, Kahle, Maxwell, and Xu (2009) and compute the market value-weighted average bond return at the bank level and use the matching portfolio approach to calculate abnormal bond returns. The matching portfolio approach matches bonds based on two primary risk factors: default risk (proxied by the bond rating) and the time to maturity. The abnormal return for bond i is then calculated by deducting the expected returns of the matched bond portfolio for bond i from the observed return of bond i. Panel B of Table A6 reports the results of the bond price event study for different time windows. We do not find any significant abnormal bond returns around the announcement dates of seasoned equity offerings.

[27] In unreported robustness checks, we also use the *MSCI Europe Index*, the *MSCI World Index*, and national stock market indices as market proxies.

Table A6
Cumulative Abnormal Returns Around Seasoned Equity Offerings

This table shows the average cumulative abnormal stock and bond returns around banks' seasoned equity offering announcements. Panel A presents the mean and median Cumulative Abnormal Stock Returns, CAR(ij) over days i to date j relative to the bank SEO announcements, segregated into announcement made by capital exercise and control group banks for the sample period and announcements during the capital exercise. The market model uses MSCI Europe Financial index returns. Panel B presents the mean and median Cumulative Abnormal Bond Returns, CAR(ij) over days i to date j relative to the bank SEO announcements, segregated into announcement made by capital exercise and control group banks for the sample period and announcements during the capital exercise. We used the matched Bond Portfolio Approach to calculate the abnormal bond returns. ***,**,* respectively denote significantly different from zero at the 1%, 5%, and 10% significance level based on a student t test.

Window		Full Sample: 2009-2013		Capital Exercise: 2011:Q3-2012:Q2	
		CEB	Control Group	CEB	Control Group
Panel A: Cumulative Abnormal Stock Returns Around Seasoned Equity Offerings					
	N	47	32	7	6
CAR(-1,0)	Mean	−1.02	−1.83**	−0.41	−1.31
	Median	−0.39	−0.70	1.10	0.27
CAR(0,1)	Mean	−1.81**	−3.48***	−1.05	−4.69**
	Median	−1.72	−1.58	0.15	−3.59
CAR(-1,1)	Mean	−1.72**	−3.06***	−0.74	−2.36
	Median	−0.98	−1.27	−1.04	−0.27
CAR(-3,3)	Mean	−2.17**	−3.08*	1.24	−5.13
	Median	−1.66	−1.93	1.26	−5.75
Panel B: Cumulative Abnormal Bond Returns Around Seasoned Equity Offerings					
	N	34	17	6	3
CAR(-1,0)	Mean	−0.02	0.02	−0.03	−0.02
	Median	0.00	−0.02	−0.11	−0.06
CAR(0,1)	Mean	0.00	0.09	0.08	0.00
	Median	0.00	−0.05	−0.07	0.10
CAR(-1,1)	Mean	−0.04	0.05	0.01	−0.08
	Median	0.00	−0.08	−0.11	0.00
CAR(-3,3)	Mean	−0.09	−0.06	−0.01	−0.50
	Median	0 − .01	−0.16	0.03	−0.72

However, if markets are not fully efficient and if new information is not immediately and correctly priced in the market, then there might be long-term abnormal stock and bond returns (Eberhart and Siddique, 2002). We therefore compare the long-term stock performance of Capital Exercise banks which issued equity relative to the *MSCI Europe Financials Index* and the long-term performance of the banks' market value-weighted bond portolios relative to their matching bond portfolios. We investigate six different event time horizons from 30 days to 300 days after a bank's equity issuance. The results are presented in Table A7. As can be seen in Column 5, we find significant abnormal positive bond returns of up to 20 percentage points for Capital Exercise banks which issued equity during the period of the capital exercise over an event time horizon of 300 days. Moreover, as can be seen in Column 7, we find positive but not significant abnormal stock returns for those banks over the same time horizon. We interpret these findings as suggestive evidence that bondholders benefited disproportionately from the equity issuances of Capital Exercise banks. Thus, our short-term and long-term event study results suggest that debt overhang and not asymmetric information is the underlying economic reason for why Capital Exercise banks were reluctant to issue equity. However overall, we feel that only little can be concluded from this event study analysis, simply due to the low frequency of seasoned equity offerings, in particular by Capital Exercise Banks.

Table A7
Long-Term Abnormal Bond and Stock Returns in Event Time

This table shows the long-term abnormal bond and stock returns in event time of Capital Exercise banks which issued equity.

	Full Sample: 2009-2013				Capital Exercise: 2011:Q3-2012:Q2			
	Abn. Bond Ret.		Abn. Stock Ret.		Abn. Bond Ret.		Abn. Stock Ret.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Days	Mean	Median	Mean	Median	Mean	Median	Mean	Median
N	29	29	32	32	6	6	5	5
30	1.99*	0.27	−3.56	−4.01**	3.99	0.41	−9.95	−3.46
60	5.32	1.79**	−2.92	−0.92	6.30	2.39	−3.38	3.93
90	10.48**	2.96***	−2.36	−3.71	9.26	5.38**	1.79	6.37
200	23.31***	8.29***	0.77	−1.99	15.70**	15.92**	11.12	20.91
300	56.93*	12.29***	2.45	4.40	19.46**	22.28	14.47	15.53

Table A8
Syndicated Lending: Intensive Margin (Credit Lines and Term Loans)

This table presents the estimates of the change in lending around the 2011 EBA capital exercise. All quarterly data for a given firm cluster are collapsed to a single before and after period. The dependent variable in Panel A (B) is Credit Line (Term Loan) Exposure, the change in the credit line (Term Loan) exposure of bank b in country i to firm cluster j between the period before (2010q3-2011q2) and after (2012q3-2013q2) the EBA capital exercise. The intensive margin sample includes country-industry firm clusters to which banks lend before and after the capital exercise. Bank characteristics include: Total Assets, CT1 Capital Ratio, Total Deposits / TA, Customer Loans / TA, Net Interest Income / Operating Revenue, and Net Income / total assets, measured in the before period. Standard errors are clustered at the bank level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

Panel A: Change in Log Credit Line Exposure

CEB	−0.33	−0.25**	−0.29***	−0.29***	−0.30***
	(0.29)	(0.10)	(0.09)	(0.09)	(0.09)
Bank Home Country FE	YES	YES	YES	YES	YES
Bank Characteristics		YES	YES	YES	YES
Borrower Home Country FE			YES	YES	
Industry FE				YES	
Borrower Home Country × Industry FE					YES
Capital Exercise Banks	45	45	45	45	45
Control Group Banks	27	27	27	27	27
Adjusted R^2	0.02	0.03	0.07	0.09	0.24
Observations	2,177	2,177	2,177	2,177	2,177

Panel B: Change in Log Term Loan Exposure

CEB	−0.10	−0.08	−0.09	−0.09	−0.10
	(0.07)	(0.10)	(0.09)	(0.09)	(0.08)
Bank Home Country FE	YES	YES	YES	YES	YES
Bank Characteristics		YES	YES	YES	YES
Borrower Home Country FE			YES	YES	
Industry FE				YES	
Borrower Home Country × Industry FE					YES
Capital Exercise Banks	45	45	45	45	45
Control Group Banks	27	27	27	27	27
Adjusted R^2	0.02	0.03	0.06	0.08	0.27
Observations	2,177	2,177	2,177	2,177	2,177

Table A9
Syndicated Lending: Intensive Margin (Home Bias Test)

This table presents the estimates of the change in lending around the 2011 EBA capital exercise. All quarterly data for a given firm cluster are collapsed to a single before and after period. The dependent variable in all specifications is Δ Log Loan Exposure, the change in the loan exposure of bank b in country i to firm cluster j between the period before (2010q3-2011q2) and after (2012q3-2013q2) the EBA capital exercise. The intensive margin sample includes country-industry firm clusters to which banks lend before and after the capital exercise. The variable Foreign Lending takes the value of one if a firm cluster is not based at the home country of bank i, and zero otherwise. Bank characteristics include: Total Assets, CT1 Capital Ratio, Total Deposits / TA, Customer Loans / TA, Net Interest Income / Operating Revenue, and Net Income / total assets, measured in the before period. Standard errors are clustered at the bank level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)
CEB	−0.09	−0.14*	−0.15*	−0.15*	−0.16**
	(0.05)	(0.08)	(0.08)	(0.08)	(0.07)
CEB × Foreign Lending	0.00	−0.01	−0.02	−0.02	−0.01
	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)
Bank Home Country FE	YES	YES	YES	YES	YES
Bank Characteristics		YES	YES	YES	YES
Borrower Home Country FE			YES	YES	
Industry FE				YES	
Borrower Home Country × Industry FE					YES
Capital Exercise Banks	45	45	45	45	45
Control Group Banks	27	27	27	27	27
Adjusted R^2	0.02	0.03	0.07	0.09	0.25
Observations	2,177	2,177	2,177	2,177	2,177

Table A10
Firm-Level Regression Analysis

This table presents the estimation results for the following difference-in-difference regressions:

$$\Delta Y_{jci} = \alpha + \beta \cdot \text{CEB Borrowing Share}_{jci} + \sum_k \theta^k X_{jci} + \eta_c + \eta_i + \epsilon_{jci}$$

where ΔY_{jci} is the change in the firm outcome variable of firm j in country c in industry i. The variable CEB Borrowing Sharejci is the share of borrowing in the syndicated loan market obtained by firm j from Capital Exercise banks in the period prior to the capital exercise. In our preferred specification the paper includes firm-level control variables X_{jci} (i.e., Log Total Assets, Tangibility, Cash Flow/TA, Net Worth, EBITDA/TA, Leverage), firm country fixed effects η_c, and industry fixed effects η_i. The firm outcome variable Y_{jci} is the change in the logarithm of total assets in Panel A, the change in the logarithm of fixed assets in Panel B, and the change in the logarithm of sales in Panel C. Standard errors are clustered at the firm-country level. *, **, and *** indicated statistical significance at the 10%, 5%, and 1% level respectively.

	(1)	(2)	(3)	(4)	(5) Non-Listed Firms	(6) Listed Firms
Panel A: Δ Log Total Assets						
EBA Borrowing Share	−0.09***	−0.07***	−0.08***	−0.08***	−0.09***	−0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.05)
Firm-Level Controls		YES	YES	YES	YES	YES
Borrower Country FE			YES	YES	YES	YES
Industry FE				YES	YES	YES
Number of Firms	2,087	2,087	2,087	2,087	1,529	558
Panel B: Δ Log Fixed Assets						
EBA Borrowing Share	−0.13***	−0.10***	−0.10***	−0.10***	−0.13***	−0.0
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Firm-Level Controls		YES	YES	YES	YES	YES
Borrower Country FE			YES	YES	YES	YES
Industry FE				YES	YES	YES
Number of Firms	2,087	2,087	2,087	2,087	1,529	558
Panel C: Δ Log Sales						
EBA Borrowing Share	−0.08***	−0.08***	−0.09***	−0.07*	−0.08**	−0.14
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.09)
Firm-Level Controls		YES	YES	YES	YES	YES
Borrower Country FE			YES	YES	YES	YES
Industry FE				YES	YES	YES
Number of Firms	2,087	2,087	2,087	2,087	1,529	558

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