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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\*

## 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 provides an almost ideal quasi-natural experiment, which allows us to identify the effect of higher capital requirements using a difference-in-differences matching estimator. We find that treated banks increase their capital ratios not by raising their levels of equity, but by reducing their credit supply. We also show that this reduction in credit supply results in lower firm-, investment-, and sales growth for firms which obtain a larger share of their bank credit from the treated banks.

*Keywords: banking, regulation, real effects of finance*

*JEL Classification: E22, E44, G21*

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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, 2010). 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 for understanding the real implications of the higher capital requirements recently imposed under Basel III.

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.<sup>1</sup> 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%.<sup>2</sup>

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<sup>1</sup>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, 2011b)

<sup>2</sup>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 DiagnePierret, 2014). As we argue in Section 2, we therefore focus on the 2011 EBA capital exercise as the main shock to EBA banks’ capital requirements.

Second, and more importantly, the rule by which banks were selected to participate in the capital exercise allows us to disentangle 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).<sup>3</sup> 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 participating and not participating in 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 EBA banks raised their core tier 1 capital ratios by 1.9 percentage points compared to banks not subject to the higher capital requirements.<sup>4</sup> 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. The control group is crucial for uncovering this finding: EBA banks increased their levels of core tier 1 capital by 21% over our sample period, but similar large European banks in the control group raised their levels of core tier 1 capital by the same magnitude. Banks can, in principle, reduce risk-weighted assets in two different ways: they can either shift from riskier assets into safer assets while keeping total asset size constant (risk reduction), or they can reduce total asset size while keeping the average asset risk constant (asset shrinking). We find that EBA banks reduced their risk-weighted assets relative to the matched control group by engaging in asset shrinking rather than risk reduction. We show that this reduction in total assets can mainly be attributed to a reduction in outstanding customer loans.

Simply observing a reduction in outstanding customer loans on banks’ balance sheets is, however, not sufficient to conclude that the supply of credit by EBA banks contracted, since this might

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<sup>3</sup>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.

<sup>4</sup>We adopt the following terminology: “EBA Banks” are banks participating in the 2011 EBA capital exercise; “Non-EBA banks” are other European banks not participating in the 2011 EBA capital exercise.

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 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 (see Acharya, Eisert, Eufinger, and Hirsch (2016); De Jonghe, Degryse, Jakovljevic, Mulier, and Schepens (2016a); De Jonghe, Dewachter, Mulier, Ongena, and Schepens (2016b)). In the loan-level part of the paper, we show 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. This result is driven by unlisted firms which are less likely to substitute a reduction in credit supply with other sources of funding.

A number of placebo and falsification tests suggest that our results are not confounded by other factors. To rule out that our results are driven by EBA banks’ exposure to the European sovereign debt crisis, we conduct a placebo test around the start of the crisis in 2010 and show that EBA 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.<sup>5</sup> 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. Predominately domestic banks in Greece, Ireland, Italy, Portugal, and Spain (GIIPS countries) increased their exposures to domestic sovereign debt (see Becker and Ivashina (2014); 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

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<sup>5</sup>Popov and Van Horen (2015) show that banks with sovereign exposures already reduced their lending in 2010, one year prior to the capital exercise.

results are driven by banks from these countries, but we do not find evidence for this alternative hypothesis. To further rule out that our results are driven by unobserved country-year-specific factors, we additionally conduct a difference-in-differences regression analysis including country-year fixed effects and show that this does not affect our main results.

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 using data on 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. Hence, these papers show in various single-country settings that increasing capital requirements (or cost) leads banks to contract lending, though only moderately so in good times.

Our paper contributes to this literature in a number of ways. First, we exploit the country-specific bank selection rule of the 2011 EBA capital exercise to identify the effects of higher capital requirements across 21 countries during times of economic distress (Acharya, Engle, and Diane Pierret, 2014).<sup>6</sup> Second, we do not only focus on bank lending, but investigate in detail how banks choose to adjust both the asset- and liability side of their balance sheets to comply with higher capital requirements. We provide empirical evidence for the recent theoretical prediction by Admati,

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<sup>6</sup>Mésonnier and Monks (2015) study the effect of the EBA capital exercise on bank lending, but do not exploit the selection rule and do not use loan-level data to disentangle credit supply from credit demand.



DeMarzo, Hellwig, and Pfleiderer (2016) that banks’ existing shareholders prefer to increase their capital ratios by reducing risk-weighted assets instead of raising new capital. Third, we study the transmission of banks’ balance sheet adjustments to the firm level and assess the effect of higher capital requirements on the real economy.

## 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 level of 9% core tier 1 ratio by the end of June 2012.<sup>7</sup>

[Figure 1 about here]

The capital exercise came mostly unexpected only a few months after the 2011 EBA stress test in June. For example, the *Financial Times* (2011) reported after the first announcement of the capital exercise on October 11, 2011 that the 9% requirement was “well beyond the current expectations of banks and analysts.” 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 the capital requirements for EBA 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 DianePierret, 2014). Thus, we naturally focus on the EBA capital exercise as the singularly overriding regulatory intervention.

The 61 EBA banks were selected based on total asset size. In each country, the EBA included “banks in descending order of their market shares by total assets”, such that the exercise covered “at

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<sup>7</sup>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 the 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 percent core tier 1 ratio.

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).<sup>8</sup> 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.

In contrast to the 2009 US Supervisory Capital Assessment Program (SCAP), which required banks “to raise additional capital, either in public markets or by issuing mandatory convertible preferred securities” (Hirtle, Schuermann, and Stiroh, 2009), the EBA left discretion to the banks which measures to take in order to comply with the higher capital requirements. In principle, banks can increase their 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, 2010). 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). EBA banks increased their capital positions by more than 200 billion euro between December 2011 and June 2012. In the final report, the EBA stated that “banks’ capital strengthening has been achieved mainly via new capital measures such as retained earnings, new equity and liability management” and that “capital strengthening has not led directly to a significant reduction in lending to the real economy” (EBA, 2012). This assessment, however, only constitutes a pure before-after comparison and does not identify EBA banks’ response to the capital exercise due to the absence of an appropriate control group. How banks adjust their balance sheets in response to the increase in capital requirements is thus an empirical question calling for a more thorough analysis.

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<sup>8</sup>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.

## 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 EBA banks. Hence, we first analyze at the bank level the extent to which the exercise changed bank behavior, in particular outstanding loan volumes. Next, we move to the individual loan level in order to disentangle credit supply from credit demand. Finally, we examine the effect of higher 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, 2011b), while leaving requirements unchanged for other European banks (i.e., our control group pool), naturally lends itself to a difference-in-differences research design. However, participation in the capital exercise was not randomly assigned to banks. Instead, the EBA selected banks according to an explicit selection rule based on bank size, resulting in EBA banks being on average larger than Non-EBA banks. This would preclude causal inference if large banks would differ from small banks, for example in terms of business models or funding strategies, and would behave differently 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 distribution of EBA banks and Non-EBA banks across different countries. While EBA banks are on average larger than Non-EBA banks, the country-specific selection threshold yields a considerable overlap in size between banks participating and not participating in 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 Cr dit 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 control group pool.

[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.<sup>9</sup> 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. The baseline matching strategy matches four Non-EBA banks to each EBA bank based on the six matching covariates.<sup>10</sup>

In addition to simply matching EBA banks to Non-EBA banks, we also employ three alternative matching strategies, each of which addresses a different potential concern. First, we match EBA banks to Non-EBA banks in the “Overlap Sample” of banks which are larger than the smallest EBA bank and smaller than the largest Non-EBA bank. The purpose of this *overlap matching strategy* is to completely remove the remaining size difference between EBA banks and Non-EBA banks and to rule out that our results are driven by bank size. Second, we match EBA banks to Non-EBA banks around the selection threshold within the same country. Therefore, we construct a “Threshold Sample” which includes the two smallest EBA banks and the two largest Non-EBA 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 business cycles. Finally, we use the threshold sample and match EBA banks to Non-EBA

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<sup>9</sup>In contrast to standard propensity score matching, the Abadie-Imbens estimator minimizes the Mahalanobis distance between a vector of observed matching covariates across banks in the treatment group and banks in the control group pool and introduces a bias-correction to account for inexact matches on continuous variables. The bias-corrected Abadie-Imbens matching estimator has the advantage of generally lowering the estimation bias (but increasing the variance) compared to matching estimators based on the estimated propensity score.

<sup>10</sup>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 bias (which is increasing in the number of matches) and variance (decreasing in the number of matches) of the matching estimator.

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 baseline matching strategy and the three alternative 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 ratio, 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 logarithm 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 EBA banks and all 494 Non-EBA 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 all subsidiaries of EBA banks, Non-EBA 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 EBA banks and 145 Non-EBA banks.<sup>11</sup> 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).

### *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

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<sup>11</sup>Table XIII lists all EBA banks in our sample. In Section III we discuss that the exclusion of 13 EBA banks does not drive our results, and that we find similar results when using the full sample of 61 EBA banks.

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 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 attribute the remaining variation in loan exposure volumes to credit supply shocks.

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

$$\Delta \text{Loan Exposure}_{bij} = \beta \cdot \text{EBA Bank}_{bi} + \gamma \cdot X_{bi} + \eta_i + \eta_j + \epsilon_{bij} \quad (1)$$

where  $\Delta \text{Loan Exposure}_{bij}$  is the change in loan exposure of bank  $b$  in country  $i$  to firm cluster  $j$  between the five quarters before the EBA capital exercise (2010Q2 - 2011Q2) and the five quarters after the capital exercise (2012Q3 - 2013Q3). The variable  $\text{EBA Bank}_{bi}$  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 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  $\eta_j$ , which absorb all cluster-specific credit demand shocks. Moreover, we include bank country fixed effects  $\eta_i$  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 pre- and post-treatment period before differencing in order to produce standard errors that are robust to concern 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 LPCs 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.<sup>12</sup> Of the 76 banks

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<sup>12</sup>For term loans and credit lines, we follow the variable definition of Berg, Saunders, and Steffen (2016).

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 syndicated members for about 32% of all 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 firm clusters to which EBA banks lend both before and after the capital exercise. Thus, this sample excludes firm clusters that entirely stop borrowing after the EBA capital exercise or do not borrow prior to the capital exercise. The intensive margin sample includes 45 EBA banks and 44 Non-EBA banks. In Section IV, we provide additional results on the extensive margin sample of firms.

### C. Firm-Level Analysis

In the final empirical step, we link the EBA banks' balance sheet adjustments to real outcomes at the firm level. A reduction in credit supply of EBA 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 EBA 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 EBA banks prior to the capital exercise, we construct the variable *EBA Borrowing Share<sub>j</sub>*:

$$\text{EBA Borrowing Share}_j = \frac{\sum_{i \in [EBABanks]} \frac{1}{5} \sum_{q=2010Q2}^{2011Q2} \text{OutstandingLoans}_{ijq}}{\sum_{i \in [AllBanks]} \frac{1}{5} \sum_{q=2010Q2}^{2011Q2} \text{OutstandingLoans}_{ijq}} \quad (2)$$

where the numerator is the average amount of outstanding loans of firm  $j$  obtained from EBA banks over the five quarters prior to the capital exercise (2010Q2 - 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 EBA borrowing share of zero, since those firms were not dependent on credit supply from EBA 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 EBA borrowing share. We then divide our sample of firms into “EBA firms” with an above median dependence on credit supply from EBA banks as measured by the EBA borrowing share (our treatment group), and “Non-EBA firms” with a below median dependence on credit supply from EBA banks (our control group pool). Since EBA firms might differ from Non-EBA 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. In the firm-level part of the paper, 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.<sup>13</sup> 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. The main outcome variables in the firm-level part of the paper are the changes in the logarithm 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.<sup>14</sup> 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 Medium 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

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<sup>13</sup>The definitions of all variables are summarized in Table XIV.

<sup>14</sup>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.



all relevant variables, which leaves us with a sample of 1,958 firms for the firm-level part of the paper.

### 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

We first provide summary statistics before and after matching under the different matching strategies. Table II shows the median pre-treatment values of the matching covariates for EBA banks, Non-EBA banks, and control group banks as of end of 2010, the year immediately prior to the capital exercise. The paper uses the continuity corrected Pearson  $\chi^2$  test statistic to test for differences in medians between the groups.

[Table II about here]

Panel A of Table II compares the 48 EBA banks with 145 Non-EBA banks. As expected, EBA banks significantly differ from Non-EBA banks along a number of important dimensions. Due to the capital exercise being carried out on the largest banks in each country, the median EBA bank is more than 20 times larger than the median Non-EBA bank. The two groups of banks also significantly differ in terms of their business models, with the median EBA bank being less engaged in customer lending and generating less of its revenue from interest income than the median Non-EBA bank. While the two groups of banks do not differ significantly with regard to their pre-treatment core tier 1 ratios, the median EBA bank is significantly less reliant on customer deposits (i.e. more reliant on wholesale funding) than the median Non-EBA bank. These large differences between EBA banks and Non-EBA banks regarding important characteristics emphasize the necessity of employing a matching procedure.

For our *baseline matching strategy*, we match four Non-EBA banks to each EBA bank based on the Mahalanobis distance of all matching covariates as of end of 2010. Panel B of Table II shows the median values of EBA banks and control groups banks based on our baseline matching

specification. The matching procedure significantly reduces the differences between EBA banks and Non-EBA banks, especially with regard to our measures for banks' business models. Some differences, however, remain significant, albeit at a much lower level compared to the unmatched sample. While EBA banks are still bigger than control group banks, our matching procedure reduces the difference from EBA banks being more than 20 times bigger to EBA banks being roughly 10 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 EBA bank and smaller than the largest Non-EBA bank, and match one Non-EBA bank to each EBA bank based on asset size only.<sup>15</sup> Panel C of Table II shows that this matching strategy reduces the size difference to 30 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-EBA banks to the two smallest EBA banks within each country using the threshold sample. To specifically address 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 EBA banks to Non-EBA banks around the selection threshold within the same region (GIIPS countries and Non-GIIPS countries).<sup>16</sup>

We first examine whether EBA 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). Identification in a difference-in-differences framework crucially relies on the parallel trend assumption to hold. We therefore examine the pre-treatment trend in the core tier 1 ratio for both EBA banks and the sample of matched control group banks according to our baseline matching strategy. Figure 3 shows a general upward trend in the core tier 1 ratios for both groups. This increase is parallel up to 2010, the year immediately prior to the capital exercise. Starting in 2011, EBA banks began to increase their core tier 1 ratios significantly more than banks in the matched control

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<sup>15</sup>In addition, we employ a difference-in-differences regression methodology in Section IV to test whether our results are driven by above median size banks.

<sup>16</sup>To test whether the results are driven by unobserved country-specific time-varying characteristics, the difference-in-differences regression framework in Section IV includes country-year fixed effects.

group.

[Figure 3 about here]

Figure 4 and Figure 5 show the trends in core tier 1 capital (the numerator of the core tier 1 ratio) and risk-weighted assets (the denominator of the core tier 1 ratio) respectively, normalized to the value of 1 for the year 2010. Both the levels of core tier 1 capital and risk-weighted assets evolved parallel for EBA banks and matched control group banks in the years leading up to the capital exercise. However, while levels of core tier 1 capital continued their parallel increase after the capital exercise, EBA banks started reducing their risk-weighted assets significantly compared to banks in the matched control group.

[Figure 4 and Figure 5 about here]

Figures 3 to 5 provide evidence that our baseline matching procedure does a good job at balancing EBA banks and Non-EBA banks with regard to their pre-treatment trends in the core tier 1 ratio and its components. Moreover, the graphs indicate that EBA banks increased their core tier 1 ratios compared to the matched control group and that they did so, not by increasing their levels of core tier 1 capital, but by reducing their levels of risk-weighted assets.

For the different matching strategies, we estimate the differences in the change in the core tier 1 ratio, the logarithm of core tier 1 capital and the logarithm of risk-weighted assets from the period before to the period after the capital exercise between EBA banks and banks in the matched control group. The first column of Panel A of Table III shows how both EBA banks and banks in the matched control group adjusted their core tier 1 ratios around the 2011 EBA capital exercise. Row 1 reports the before-after differences for EBA banks, Row 2 the before-after differences for control group banks, Row 3 the unmatched difference-in-differences results, and Row 4 the bias-corrected Abadie and Imbens (2002) matching estimator for the average treatment effect on the treated (ATT). Both EBA 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 1.79 percentage points on average, EBA banks did so by 3.02 percentage points and thus significantly more than banks not subject to higher capital requirements. The ATT equals

1.85 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 participating in the capital exercise.

[Table III about here]

The second column of Panel A of Table III shows that EBA 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, e.g. market pressure on banks to raise capital, rather than an effect of the capital exercise. European banks not participating in 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 EBA 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 EBA banks and matched control group banks around the capital exercise, as can be seen in the third column of Panel A of Table III. While EBA banks reduced their levels of risk-weighted assets by 10% over our sample period, control group banks even increased their levels of risk-weighted assets. The ATT indicates that EBA 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 combined findings in Table III are the first central result of the bank-level part of the 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).<sup>17</sup> 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 III 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 EBA banks responded to the increase in capital requirements by reducing their risk-weighted assets compared to banks in the control group.

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<sup>17</sup>When using the sample of all 61 EBA banks, we find that EBA 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 difference with regard to the levels of core tier 1 capital.

EBA banks could achieve this relative reduction in risk-weighted assets either by changing their asset composition from riskier assets into safer assets while keeping total asset size constant (risk reduction), or by reducing total asset size while keeping the average asset risk constant (asset shrinking). Asset shrinking has potential negative effects on the real economy if a large fraction of banks simultaneously decides to reduce lending. In order to examine whether EBA banks reduced their risk-weighted assets via risk reduction, Panel A of Table IV reports the matching estimation results for two different measures of banks’ asset risk as the outcome variable. Risk reduction behavior would imply a reduction in the ratio of risk-weighted assets over total assets. The first column, however, shows that there is no statistically significant difference in the changes of this ratio between EBA banks and banks in the matched control group. While EBA banks did indeed reduce risk-weighted assets relative to total assets (see also Acharya and Steffen (2015)), so did banks in the matched control group, again reflecting a general development in the European banking system rather than an effect of higher capital requirements. Similarly, the second column shows that there is neither a significant treatment effect with regard to loan loss reserves relative to outstanding customer loans.

[Table IV about here]

In Panel B of Table IV, we investigate whether EBA banks reduced their risk-weighted assets by engaging in asset shrinking. The first column shows that EBA banks reduced total assets by 14 percentage points compared to banks in the matched control group. The EBA’s final report on the capital exercise claims that “capital plans have not led directly to a significant reduction of lending into the real economy” (EBA, 2012). The second column of Panel B shows that EBA banks did indeed not reduce outstanding customer loans after the capital exercise. However, control group banks increased customer loans by 8 percentage points during the same period. The matching estimator indicates that EBA 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. We also document a negative treatment effect on security holdings of EBA banks.<sup>18</sup> However, as customer loans make up 60% of the average EBA bank’s balance sheet while security holdings only

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<sup>18</sup>Boyson, Helwege, and Jindra (2014) find that when banks “sell assets, they cherry pick assets in order to alleviate pressure from capital regulations”.

make up 27%, the asset shrinking behavior of EBA banks can mainly be attributed to a reduction in outstanding customer loans.

In Section IV, we provide additional results and employ a battery of robustness checks to show that our bank-level results are robust to a number of alternative specifications.

### *B. Loan-Level Results*

To rule out that the reduction in outstanding customer loans of EBA banks 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 EBA 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 EBA banks and control group banks, normalized to the value of 1 for 2011Q2, the quarter immediately prior to the capital exercise. There is a parallel upward trend in syndicated loan volumes leading up to the capital exercise. Starting in the third quarter of 2011, loan volumes of EBA banks started to stagnate and then decrease, while loan volumes for banks in the matched control group kept increasing.

[Figure 6 about here]

Table V presents the results of the difference-in-differences regression specification (1) in the spirit of Khwaja and Mian (2008) for the intensive margin sample. The first column of Table V shows that EBA banks reduced their exposures in the syndicated loan market by 14 percentage points after the capital exercise compared to banks in the control group. This specification includes bank country fixed effects which absorb unobserved shocks affecting all banks in a given country. The second column of Table V 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 25 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 EBA banks having different exposures to different industries than Non-EBA 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-industry fixed effects in the fifth column respectively. In the fifth and strongest specification, which rules out that our results are driven by borrower country-industry specific demand shocks, we find that EBA banks reduced their exposures in the syndicated loan market by 27 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.<sup>19</sup>

[Table V about here]

These results are consistent with the bank-level part of the paper: EBA banks responded to the increase in capital requirements by reducing outstanding customer 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 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. To investigate this, we divide our sample of firms into “EBA firms” with an above median dependence on credit supply from EBA banks as measured by the EBA borrowing share (our treatment group), and “Non-EBA firms” with a below median dependence on credit supply from EBA banks (our control group pool). The average EBA borrowing share of a firm in the sample is 54% with a standard deviation of 36.5 percentage points. Since EBA firms might differ from Non-EBA 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 VI shows the median pre-treatment values of the matching covariates for EBA firms, Non-EBA firms, and control group firms as of end of 2010, the year immediately prior to the capital

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<sup>19</sup>While the results in Fraisse, Lé, and Thesmar (2015) are driven by the extensive margin of lending, our results are driven by the intensive margin, as we show in Section IV.

exercise. The paper uses the continuity corrected Pearson  $\chi^2$  test statistic to test for differences in medians between the groups.

[Table VI about here]

Panel A of Table VI compares the 952 EBA firms with 1,006 Non-EBA firms in the unmatched sample. EBA firms are on average larger than Non-EBA firms in terms of total assets, with the difference being significant at the 1% level. While none of the differences in other firm characteristics are significant at the 1% level, the difference in firm size is our biggest concern and confirms the need for employing a matching procedure. Analog to our matching strategy in the bank-level part of the paper, we match four Non-EBA firms to each EBA firm based on the Mahalanobis distance of all matching covariates as of end of 2010. This matching procedure significantly reduces the size difference between EBA firms and Non-EBA firms, rendering the difference insignificant at the 5% level. While the matching introduces a statistically significant difference in terms of leverage between the two groups of firms, we argue that this difference of less than two percentage points is not economically meaningful.

Analog to the bank-level part of the paper, we first investigate whether the parallel trend assumption holds with regard to firms' corporate policies. Figure 7, Figure 8, and Figure 9 show the evolution of total assets, fixed assets, and sales for unlisted EBA firms and firms in the matched control group respectively, each normalized to the value of 1 for the year 2010. Each of the figures show that EBA firms and Non-EBA firms developed similarly up to 2010, the year prior to the capital exercise. Starting in 2011, EBA 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 difference in changes in log total assets, log fixed assets, and log sales from the period before to the period after the capital exercise between EBA 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 VII shows how the 2011 EBA capital exercise affected total assets, fixed assets, and sales of all firms in our sample. Row 1 reports the



before-after differences for EBA firms, Row 2 the before-after differences for control group firms, Row 3 the unmatched difference-in-differences results, and Row 4 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 EBA banks had a significant negative effect on asset-, investment-, and sales growth of EBA firms. EBA firms on average grew by four percentage points less, exhibited six percentage points less investment growth, and five percentage points less sales growth, than firms in the matched control group less reliant on funding from EBA banks.

[Table VII about here]

Panel B and C of Table VII report separate results for the subsample of unlisted and listed 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 EBA firms exhibited six percentage points less asset growth and nine 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 EBA banks in response to higher capital requirements yielded significant negative effects for firms which obtained a large share of their funding from EBA 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 show that our results from the bank-level, loan-level, and firm-level part are robust to a number of alternative specifications.

### A. *Bank-Level Robustness Checks*

#### A.1. **Adjustment of Weakly and Strongly Capitalized Banks**

The EBA capital exercise required EBA banks to increase their core tier 1 ratio to 9% over the period from December 2011 to June 2012. EBA 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 ratio beyond the target ratio of 9%. Therefore, our results should be driven by weakly capitalized EBA 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-EBA banks to each EBA bank based on the 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. Panel A of Table VIII shows the results for the subsample of weakly capitalized banks, and Panel B of Table VIII 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 EBA 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.<sup>20</sup> 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 EBA 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 VIII about here]

## A.2. Placebo Tests

One concern is that our results might be driven by EBA banks' exposure to the European sovereign debt crisis. The European sovereign debt crisis started in 2010 (Popov and Van Horen, 2015). If differences in balance sheets adjustments between EBA 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

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<sup>20</sup>Note that the matching estimator produces extreme results in Table VIII 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 EBA banks reduced their risk-weighted assets and did not increase core tier 1 capital compared to banks in the matched control group.

a placebo matching exercise for the period of the start of the sovereign debt crisis (2009-2010) and show that EBA banks and control group banks exhibited a similar change in their levels of core tier 1 capital and risk-weighted assets during this placebo period. The results from this placebo test are reported in Table IX and show that EBA banks did neither 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 EBA banks reduced their risk-weighted assets by six 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 3 and not significant at the 5% level. The placebo test suggests that the differences between EBA 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 not be attributed to the European sovereign debt crisis.

[Table IX about here]

### A.3. Bank-Level Regression Analysis

In this section, we provide additional robustness checks within a difference-in-differences regression framework to rule out concerns that our bank-level results might be driven by country-specific factors, bank size, banks' funding strategies, and exposure to the European sovereign debt crisis. We estimate the following difference-in-differences regression specification:

$$Y_{ict} = \alpha + \beta \cdot EBA_{ic} + \gamma \cdot After_t + \delta \cdot (EBA_{ic} \times After_t) + \sum_k \theta^k X_{i,t-1} + \eta_i + \eta_{ct} + \epsilon_{ict} \quad (3)$$

where  $Y_{ict}$  is the outcome variable of bank  $i$  in country  $c$  in year  $t$ , specifically the bank's core tier 1 ratio, log core tier 1 capital, and log risk-weighted assets. The variable  $EBA_{ic}$  takes on the value 1 for the 48 EBA banks and 0 for the 145 Non-EBA banks. The variable  $After_t$  takes on the value 1 for the years 2012 and 2013, and 0 for the years 2009 and 2010. In our preferred specification, we include bank fixed effects  $\eta_i$  and country-year fixed effects  $\eta_{ct}$ , whereas the inclusion of the former absorbs the level effect of the  $EBA_{ic}$  variable and the inclusion of the latter controls for different macroeconomic developments (in particular demand for financial intermediation) and supervisory regimes across different countries. Furthermore, the regression parametrically controls for differ-

ences across EBA banks and Non-EBA banks by including a range of lagged bank characteristics  $X_{i,t-1}$ , namely the logarithm of 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.<sup>21</sup>

The results of the difference-in-differences regression are shown in Table X. The first column contains a benchmark specification including year fixed effects instead of country-year fixed effects, and the second column contains our favorite specification including country-year fixed effects. Panel A of Table X shows that EBA banks increased their core tier 1 ratio by 1.53 percentage points more than Non-EBA banks, confirming the main findings in Section III. Moreover, Panel B and Panel C respectively show that EBA banks did not increase their levels of core tier 1 capital, but instead reduced their risk-weighted assets by 11 percentage points compared to Non-EBA banks.

[Table X about here]

In the third column, we conduct an additional robustness check whether the results are driven by large EBA banks. We therefore include an additional interaction term containing the variables *Large Banks*, which takes on the value 1 for all banks larger than the median EBA bank in terms of pre-treatment levels of total assets, and 0 otherwise. This interaction term is not significant and does not alter the results in any of the panels, providing evidence that the results are not driven by large banks in the sample.

In the fourth column, we test whether differences in funding strategies between EBA banks and Non-EBA banks can explain the results. We therefore include an additional interaction term containing the variable *Deposit Funding*, which takes on the value 1 for all banks with a larger than median deposit share of total assets, and 0 otherwise. Again, this interaction term is not significant in any of the panels, suggesting that the results are not driven by differences in the funding strategy between EBA banks and Non-EBA banks.

Finally, a further concern is that there are other contaminating events, such as moral suasion by governments (Becker and Ivashina (2014); Ongena, Popov, and Van Horen (2016)) or the ECB’s longer-term refinancing operations (LTRO) (Carpinelli and Crosignani, 2015) which possibly provide alternative explanations for our results. However, Becker and Ivashina (2014) and Van Rixtel

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<sup>21</sup>These variables are the same as the matching covariates in Section III.

and Gasperini (2013) document that in particular banks in Greece, Ireland, Italy, Portugal and Spain (GIIPS) increased their exposures to domestic sovereign debt and made use of the ECB’s LTRO program. In the fifth column, we thus test whether the results are purely driven by EBA banks from GIIPS countries. We therefore include a triple interaction term containing the variable GIIPS, which takes on the value 1 for banks from GIIPS countries, and 0 otherwise. The results remain unchanged, providing evidence that our main results are not purely driven by EBA banks from GIIPS countries.

### *B. Loan-Level Robustness Checks*

In the loan-level part, we studied the intensive margin sample of firm clusters to which EBA 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 firm clusters. To investigate this, we estimate the following regression specification:

$$Y_{bij} = \alpha + \beta \cdot EBA_{bi} + \gamma X_{bi} + \eta_i + \eta_j + \epsilon_{bij} \quad (4)$$

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  $EBA_{bi}$  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 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), bank country fixed effects  $\eta_i$ , and firm cluster fixed effects  $\eta_j$ , which absorb all cluster-specific credit demand shocks.

The first three columns of Table XI provide evidence that EBA banks did not stop lending to specific firm clusters after the capital exercise. The fourth column suggests that EBA 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 XI about here]

### C. *Firm-Level Robustness Checks*

In the firm-level part of the paper, we define EBA firms (Non-EBA firms) as firms with an above (below) median dependence on credit supply from EBA banks as measured by the EBA borrowing share. In this section, we provide additional robustness checks within a regression framework in which we include the EBA borrowing share as a continuous variable. We estimate the following regression specification:

$$Y_{jci} = \alpha + \beta \cdot \text{EBA Borrowing Share}_{jci} + \sum_k \theta^k \cdot X_{jci} + \eta_c + \eta_i + \epsilon_{jci} \quad (5)$$

where  $Y_{jci}$  is the change in the firm outcome variable of firm  $j$  in country  $c$  in industry  $i$ , in particular the change in the logarithm of total assets, the logarithm of fixed assets, and logarithm of sales. In our preferred specification we include firm-level control variables  $X_{jci}$  (i.e., log total assets, tangibility, cash flow over total assets, net worth, EBITDA over total assets, and leverage), firm country fixed effects  $\eta_c$ , and industry fixed effects  $\eta_i$ .

Panel A of Table XII shows that the EBA borrowing share is negatively associated with firm asset growth between the period before and after the capital exercise. These results hold when controlling subsequently for firm characteristics, firm country fixed effects, and industry fixed effects. In the strongest specification in the fourth column, we find that a firm with an EBA borrowing share of 100% reduces total assets by 7 percentage points compared to a firm with an EBA borrowing share of 0%. A one standard deviation increase in the EBA borrowing share reduces total asset growth by 2.3 percentage points. The fifth and sixth columns show that these findings are driven by unlisted firms, while results are not significant for listed firms. Panels B and Panel C of Table XII show the analogous findings for investment growth and sales growth. A one standard deviation increase in the EBA borrowing share is associated with a 3.3 percentage point decrease in investment growth and a 2.4 percentage point decrease in sales growth. Again, these results are driven by unlisted firms, and are not significant for listed firms.

[Table XII 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 a matching strategy that exploits the selection rule of the EBA capital exercise, we show that EBA banks increase their core tier 1 ratio more than Non-EBA 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. However, the analysis also shows that banks do not raise their capital ratios by increasing their levels of core tier 1 capital, but by reducing credit supply, which in turn has significant effects on the corporate sector.

Firms which are more reliant on credit supply by EBA banks exhibit lower asset-, investment-, and sales growth than firms less reliant on EBA banks. This suggests that firms were unable to fully substitute the reduction in credit supply by EBA banks with other sources of financing. EBA 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 EBA firms 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 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.

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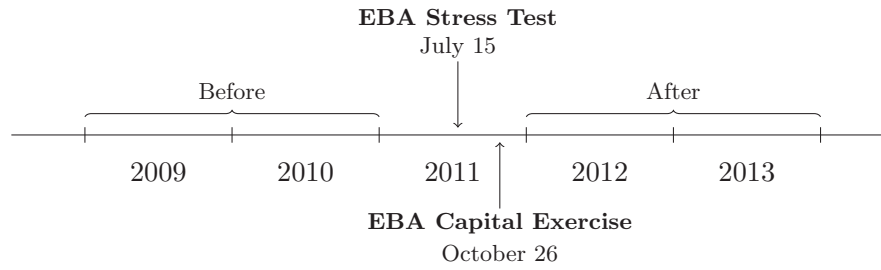


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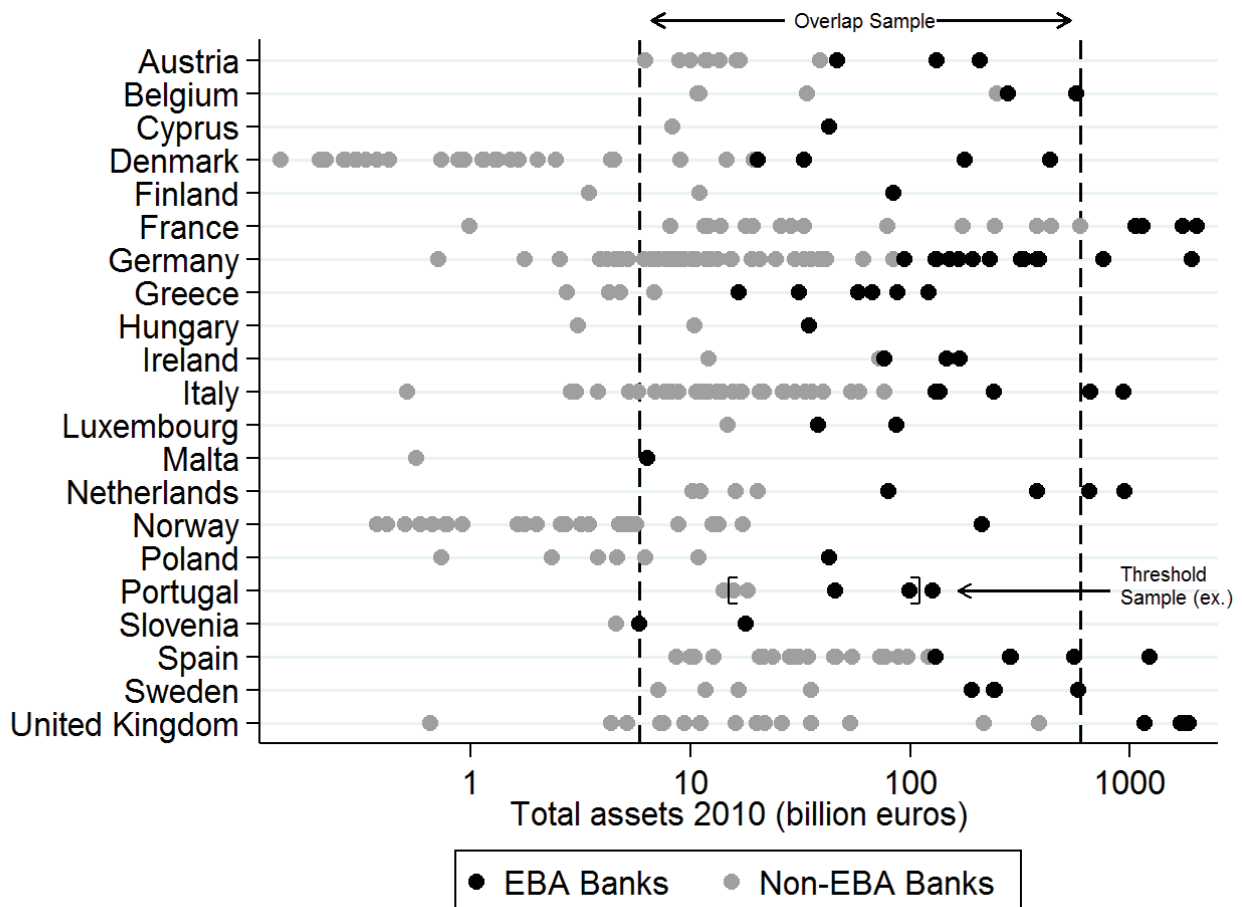
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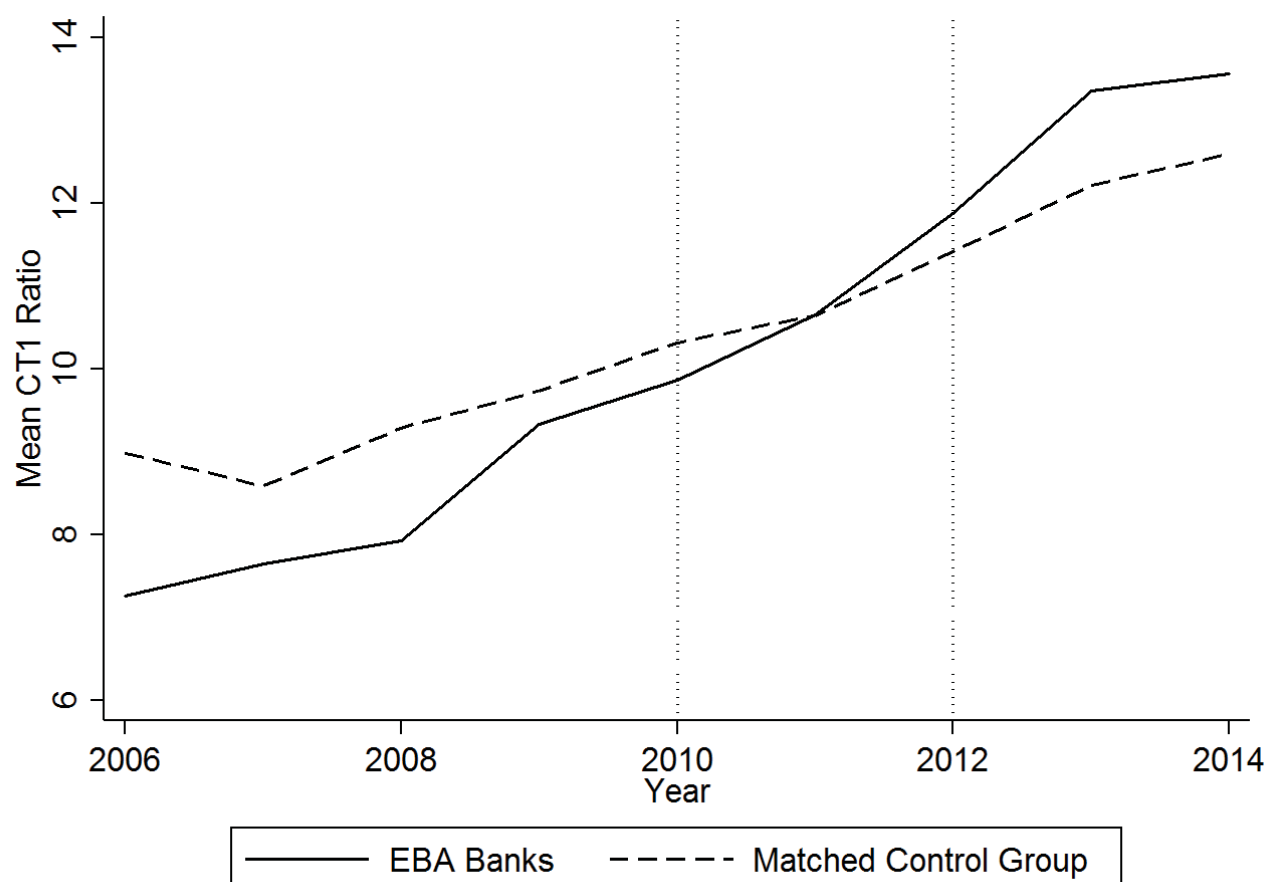
## Appendix A: Figures



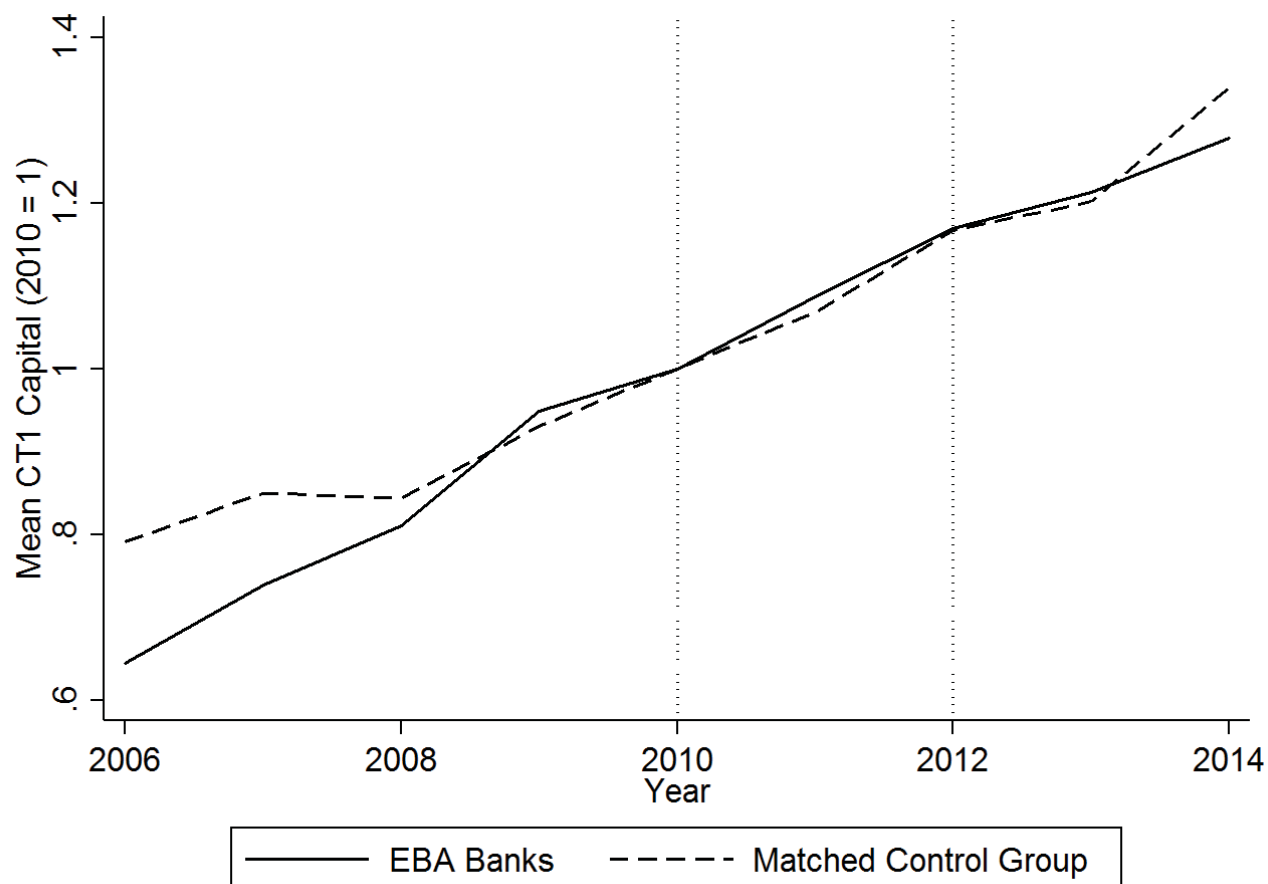
**Figure 1. EBA Capital Exercise Timeline.** Figure 1 shows the timeline of the 2011 EBA capital exercise including our definition of the before and after period used in the paper.



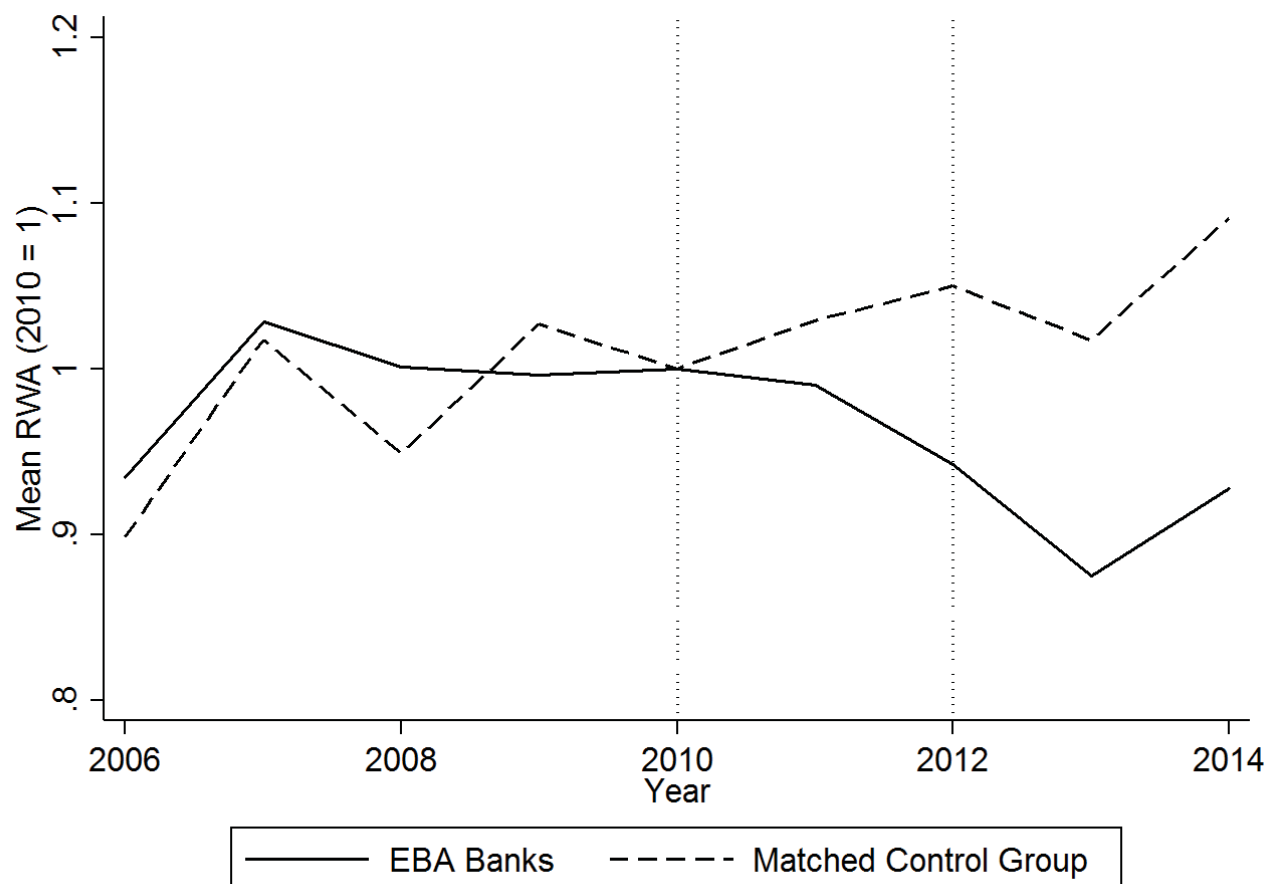
**Figure 2. Bank Size Distribution by Country.** Figure 2 shows the bank size distribution (total assets as of end of 2010) of EBA banks and Non-EBA banks by country. The graph includes all ultimate parent banks headquartered in EBA supervised countries included in the SNL database. The figure illustrates the construction of the overlap sample and the threshold sample. The overlap sample includes all banks larger than the smallest EBA bank (left vertical line) and smaller than the largest Non-EBA 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.** Figure 3 shows the evolution of the mean core tier 1 ratio over time for both 48 EBA banks in the treatment group and 76 Non-EBA banks in the matched control group. The two vertical lines mark 2010 and 2012, the years immediately before and after the capital exercise.

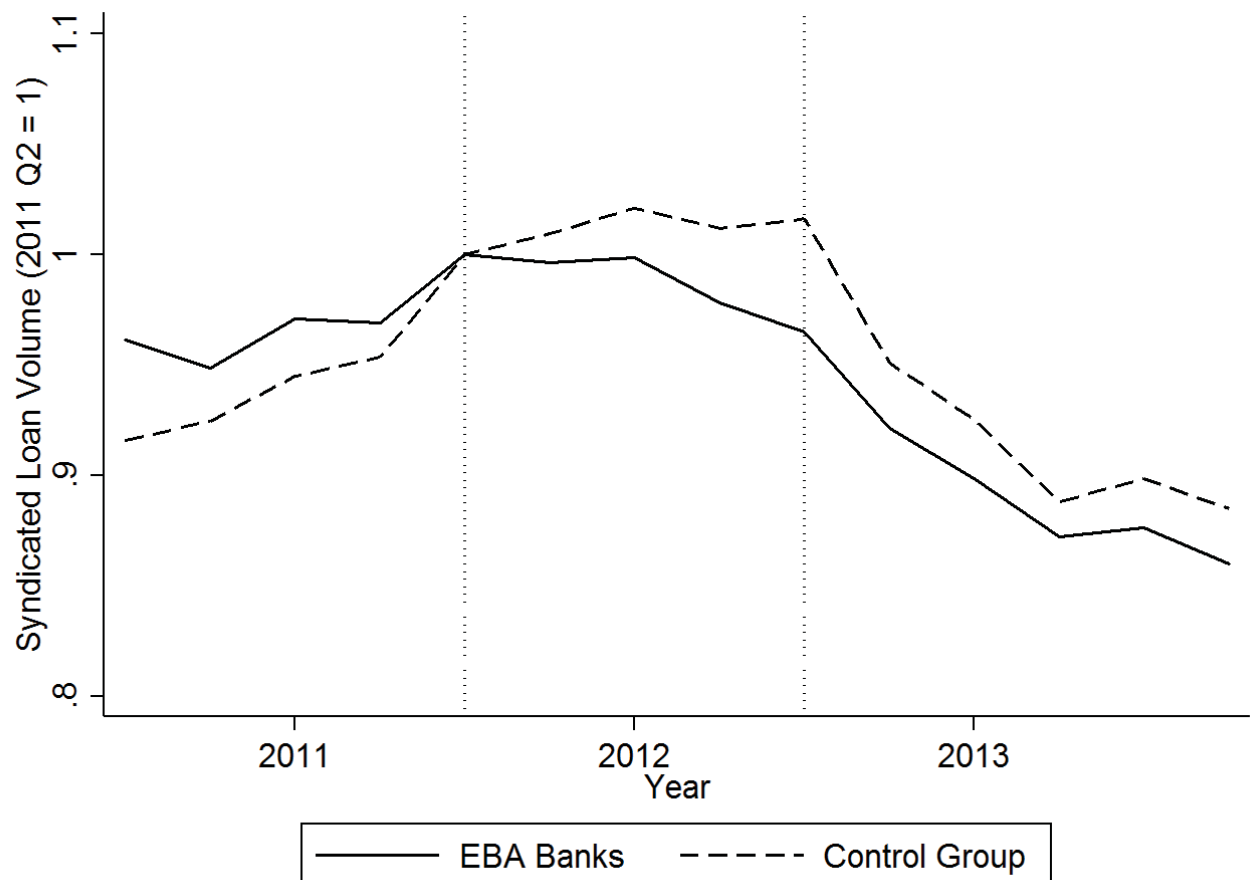


**Figure 4. Core Tier 1 Capital over Time.** Figure 4 shows the evolution of the levels of mean core tier 1 capital over time for both 48 EBA banks in the treatment group and 76 Non-EBA banks in the matched control group, normalized to the value of 1 for the year 2010. The two vertical lines mark 2010 and 2012, the years immediately before and after the capital exercise.

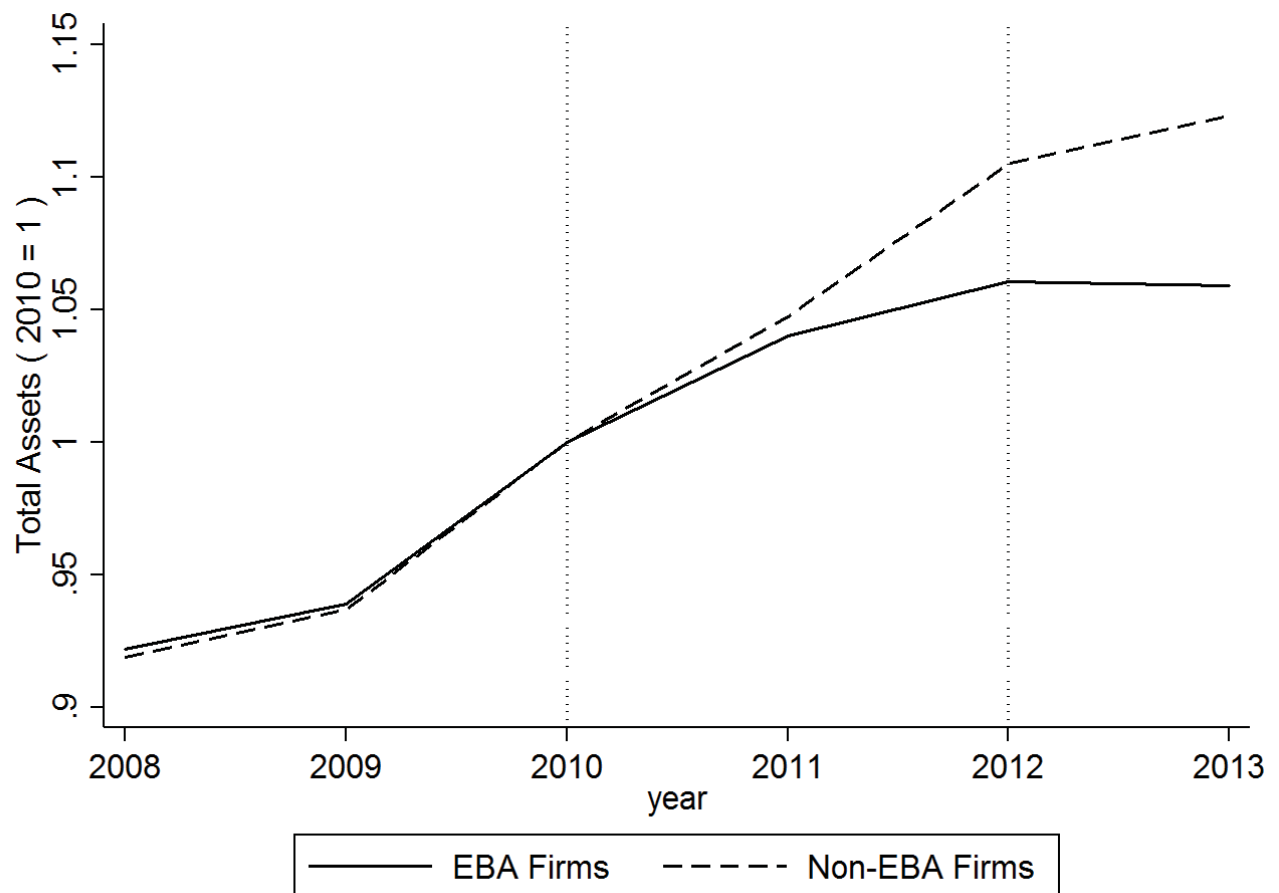


**Figure 5. Risk-Weighted Assets over Time.** Figure 5 shows the evolution of the levels of mean risk-weighted assets over time for both 48 EBA banks in the treatment group and 76 Non-EBA banks in the matched control group, normalized to the value of 1 for the year 2010. The two vertical lines mark 2010 and 2012, the years immediately before and after the capital exercise.

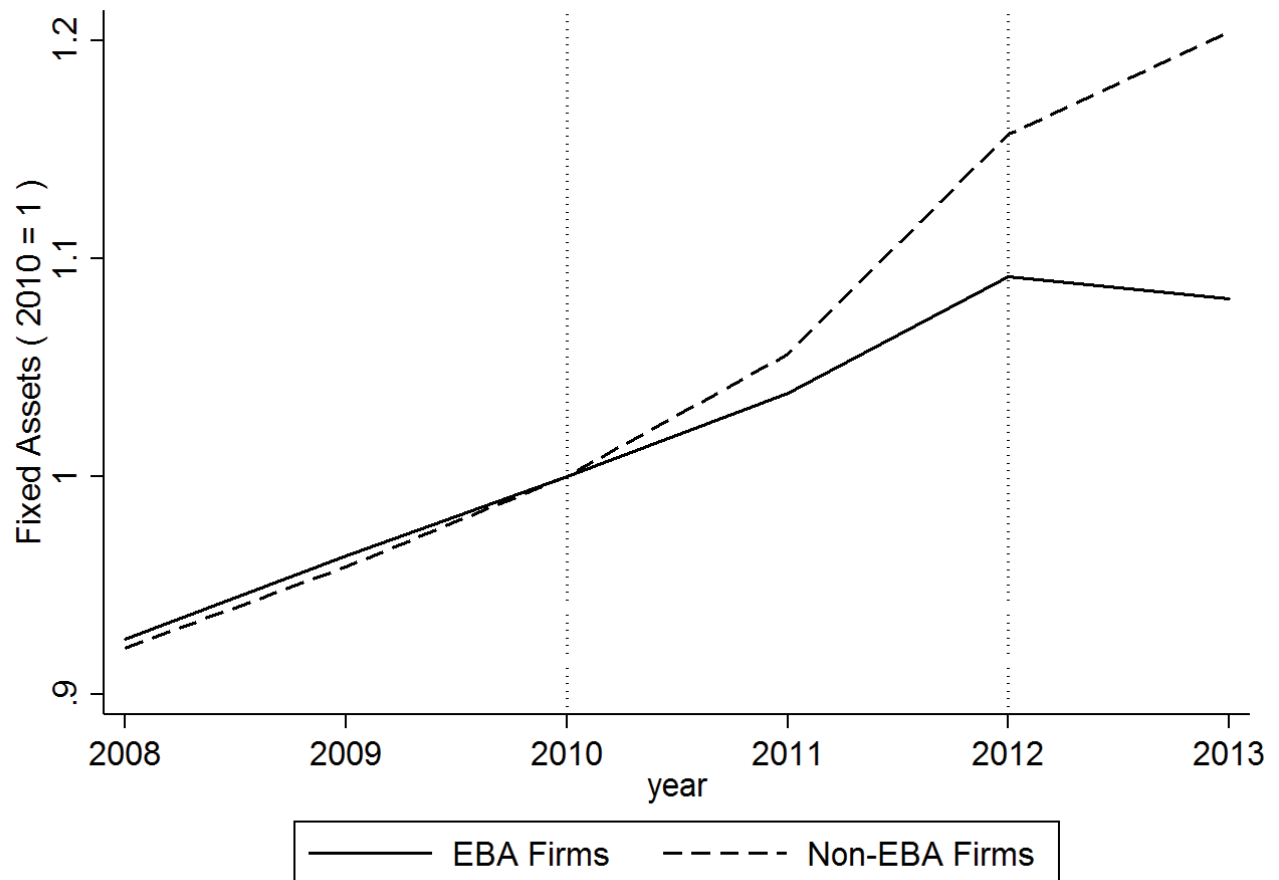




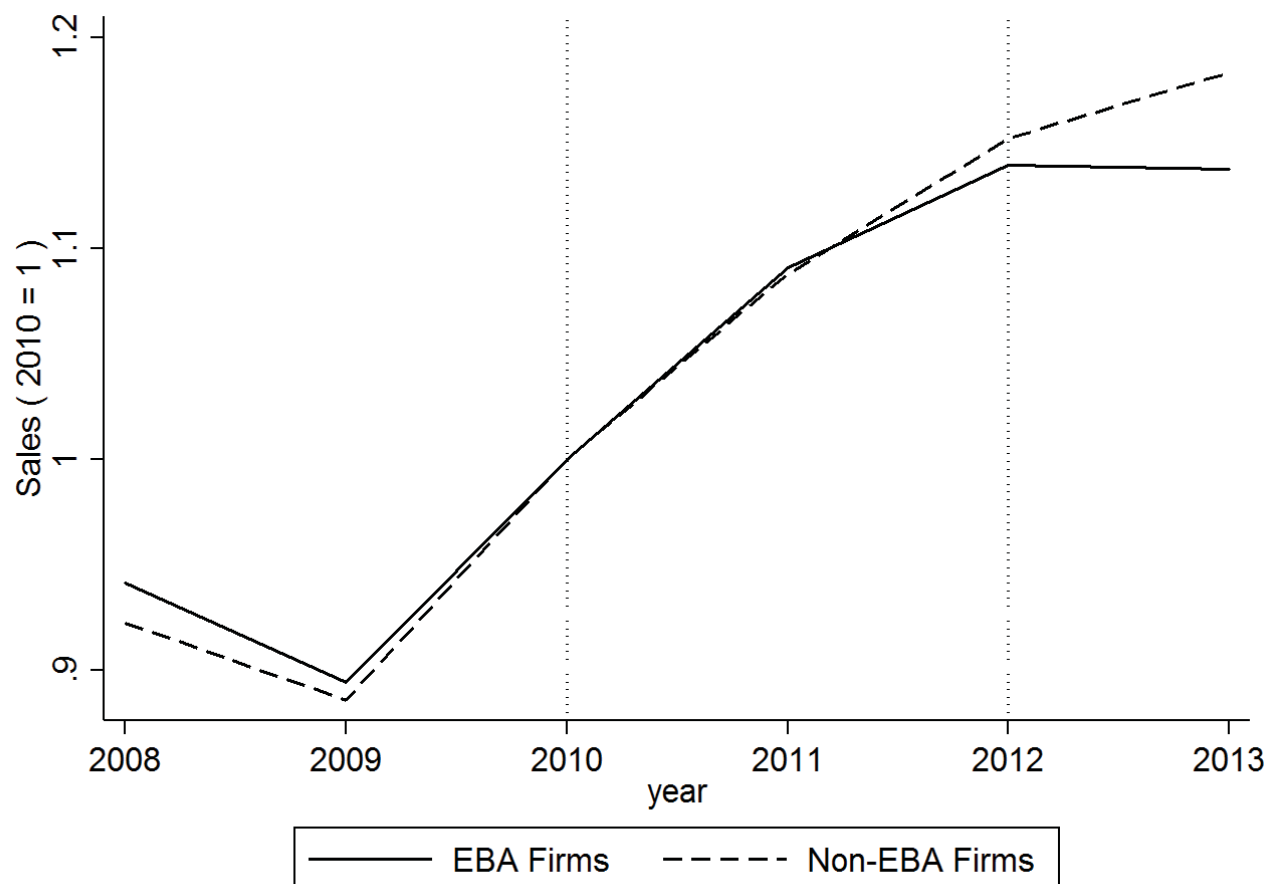
**Figure 6. Syndicated Loan Volume over Time.** Figure 6 shows the outstanding loan volume of EBA banks and Non-EBA banks in the syndicated loan market over the period 2010Q1-2013Q4, normalized to the value of 1 in 2011Q2. The two vertical lines mark 2011Q2 and 2012Q2, the quarters immediately before and after the capital exercise.



**Figure 7. Firm Total Assets over Time.** Figure 7 shows the evolution of the mean total assets for both 681 unlisted EBA firms and 793 unlisted Non-EBA firms in the matched control group, normalized to the value of 1 for the year 2010. The two vertical lines mark 2010 and 2012, the years immediately before and after the capital exercise.



**Figure 8. Firm Fixed Assets over Time.** Figure 8 shows the evolution of the mean fixed assets for both 681 unlisted EBA firms and 793 unlisted Non-EBA firms in the matched control group, normalized to the value of 1 for the year 2010. The two vertical lines mark 2010 and 2012, the years immediately before and after the capital exercise.



**Figure 9. Firm Sales over Time.** Figure 9 shows the evolution of the mean sales for both 681 unlisted EBA firms and 793 unlisted Non-EBA firms in the matched control group, normalized to the value of 1 for the year 2010. The two vertical lines mark 2010 and 2012, the years immediately before and after the capital exercise.

## Appendix B: Tables

**Table I**  
**Matching Strategies**

Table I displays the baseline matching strategy and three alternative matching strategies employed in the paper. The *Baseline Sample* includes 48 EBA banks and 145 Non-EBA banks. The *Overlap Sample* includes all banks larger than the smallest EBA bank and smaller than the largest Non-EBA bank. The *Threshold Sample* includes the two smallest EBA banks and the two largest Non-EBA Banks per country. The number of matches refers to the number of control group banks matched to each EBA 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	Baseline	Overlap	Within Country	Within Region
Sample Used	Baseline	Overlap	Threshold	Threshold
Number of Matches	1:4	1:1	1:2	1:4
<i>Matching covariates</i>				
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**  
**Pre-Treatment Characteristics of Banks**

Table II provides pre-treatment summary statistics on EBA banks, Non-EBA banks and matched control group banks (median comparisons). We test for differences in medians using the continuity corrected Pearson  $\chi^2$  test statistic. Panel A compares the median values of 48 EBA banks and 145 Non-EBA banks in the unmatched sample. Panel B compares EBA banks to the sample of matched control group banks using the *baseline matching strategy*. Panels C-D compare EBA banks to the sample of matched control group banks using the *overlap matching strategy*, the *within country matching strategy*, and the *within region matching strategy* respectively. The matching covariates used in each matching strategy are listed in Table I. \*, \*\*, and \*\*\* indicate statistical significance at the 10%, 5%, and 1% level respectively.

	# Banks	Total Assets	CT1 Ratio	Deposits / TA	Loans / TA	NII / Op. Rev.	Net Inc. / TA
<i>Panel A: Unmatched Sample</i>							
EBA Banks	48	183.21	9.21	40.47	60.03	57.94	0.40
Non-EBA Banks	145	9.05	10.54	56.25	70.62	68.97	0.29
$\Delta$		174.16***	-1.32	-15.78***	-10.60***	-11.03**	0.11
<i>Panel B: Baseline Matching</i>							
EBA Banks	48	183.21	9.21	40.47	60.03	57.94	0.40
Matched Group Group	76	18.39	10.04	50.29	64.73	65.08	0.39
$\Delta$		164.83***	-0.83	-9.82***	-4.70*	-7.14	0.01
<i>Panel C: Alternative Matching Strategy 1 (Overlap Matching)</i>							
EBA Banks	36	130.43	9.31	43.24	62.49	64.04	0.41
Matched Group Group	16	97.10	10.95	56.74	59.28	55.99	0.37
$\Delta$		33.33	-1.64	-13.50***	3.20	8.06	0.04
<i>Panel D: Alternative Matching Strategy 2 (Within Country Matching)</i>							
EBA Banks	26	130.43	9.80	44.55	64.57	60.67	0.42
Matched Group Group	26	10.55	10.85	43.29	67.62	66.86	0.34
$\Delta$		119.88***	-1.04	1.26	-3.05	-6.19	0.08
<i>Panel E: Alternative Matching Strategy 3 (Within Region Matching)</i>							
EBA Banks	26	130.43	9.80	44.55	64.57	60.67	0.42
Matched Group Group	26	30.48	9.88	51.60	65.65	60.23	0.38
$\Delta$		99.95**	-0.08	-7.05	-1.08	0.44	0.04

**Table III**  
**Adjustment of Core Tier 1 Ratios**

Table III presents the estimates of 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 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 EBA 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 unmatched difference-in-differences estimates comparing the treatment group of EBA banks to the control group. The fourth 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). Panel A presents the results for the *baseline matching strategy*, Panel B the results for the *overlap matching strategy*, Panel C 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	$\Delta$ CT1 Ratio (1)	$\Delta$ Log CT1 Capital (2)	$\Delta$ Log RWA (3)
<i>Panel A: Baseline Matching</i>			
EBA Banks: Before - After	3.02***	0.19***	-0.10***
Control Group: Before - After	1.79***	0.17***	0.03
DID: EBA vs. Control Group	1.23***	0.02	-0.13***
Matching Estimator (ATT)	1.85***	0.02	-0.16***
Number of observations	48	48	48
<i>Panel B: Alternative Matching Strategy 1 (Overlap Matching)</i>			
EBA Banks: Before - After	3.08***	0.18***	-0.11***
Control Group: Before - After	2.40***	0.29***	0.08**
DID: EBA vs. Control Group	0.68	-0.11**	-0.19***
Matching Estimator (ATT)	0.71	-0.10	-0.19**
Number of observations	36	36	36
<i>Panel C: Alternative Matching Strategy 2 (Within Country Matching)</i>			
EBA Banks: Before - After	3.16***	0.17***	-0.10***
Control Group: Before - After	2.26***	0.21***	0.02
DID: EBA vs. Control Group	0.90	-0.04	-0.12**
Matching Estimator (ATT)	1.05*	-0.09*	-0.16***
Number of observations	26	26	26
<i>Panel D: Alternative Matching Strategy 3 (Within Region Matching)</i>			
EBA Banks: Before - After	3.16***	0.17***	-0.10***
Control Group: Before - After	2.13***	0.25***	0.05***
DID: EBA vs. Control Group	1.03***	-0.08***	-0.15***
Matching Estimator (ATT)	1.02**	-0.07	-0.14**
Number of observations	26	26	26

**Table IV**  
**Asset Reduction versus Asset Shrinking**

Table IV presents the estimates of the changes in outcome variables associated with risk reduction (Panel A) and asset shrinking (Panel B). Panel A presents the estimates of the *change in the ratio of risk-weighted assets over total assets* and the *change in the ratio of loan loss reserves over total net customer loans*. Panel B presents the estimates of the *change in the logarithm of total assets*, the *change in the logarithm of total net customer loans*, and the *change in the logarithm of total securities*. 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 EBA 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 unmatched difference-in-differences estimates comparing the treatment group of EBA banks to the control group. The fourth 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) using the baseline matching strategy. \*, \*\*, and \*\*\* indicate statistical significance at the 10%, 5%, and 1% level respectively.

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*Panel A: Risk Reduction*

Dependent Variable	$\Delta$ (RWA/TA) (1)	$\Delta$ (LLR/ Cust.Loans) (2)
EBA Banks: Before - After	-5.93**	1.53***
Control Group: Before - After	-4.12**	1.08**
DID: EBA vs. Control Group	-1.81*	0.45
Matching Estimator (ATT)	-0.57	0.69
Number of observations	193	164

*Panel B: Asset Shrinking*

Dependent Variable	$\Delta$ Log Total Assets (1)	$\Delta$ Log Cust. Loans (2)	$\Delta$ Log Total Securities (3)
EBA Banks: Before - After	0.03	0.01	0.07
Control Group: Before - After	0.10***	0.08**	0.15***
DID: EBA vs. Control Group	-0.07**	-0.07**	-0.08
Matching Estimator (ATT)	-0.14***	-0.12***	-0.17**
Number of observations	193	193	193

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**Table V**  
**Syndicated Lending: Intensive Margin**

Table V presents the estimates of the change in lending around the 2011 EBA capital exercise. The dependent variable in all specifications is the *change in outstanding syndicated loan volumes* of bank  $b$  in country  $i$  to firm cluster  $j$  between the period before (2010Q2-2011Q2) and after (2012Q3-2013Q3) the EBA capital exercise. The intensive margin sample includes firm clusters to which banks lend before and after the capital exercise. Bank characteristics include the logarithm of 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, as of end of 2010. 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)
EBA Bank	-0.14** (0.06)	-0.25** (0.10)	-0.26*** (0.10)	-0.27*** (0.10)	-0.27*** (0.09)
Bank Country FE	YES	YES	YES	YES	YES
Bank Characteristics		YES	YES	YES	YES
Borrower Country FE			YES	YES	
SIC FE				YES	
Borrower Country x SIC FE					YES
Treatment Banks	45	45	45	45	45
Control Group Banks	44	44	44	44	44
Adjusted $R^2$	0.03	0.03	0.06	0.08	0.29
Observations	2,254	2,254	2,254	2,254	2,254

**Table VI**  
**Pre-Treatment Characteristics of Firms**

Table VI provides pre-treatment summary statistics on EBA firms, Non-EBA firms and matched control group firms (median comparisons). EBA firms are firms obtaining an above-median share of their borrowing from EBA banks in the pre-treatment period. Non-EBA firms are firms obtaining a below-median share of their borrowing from EBA banks. The paper tests for differences in medians using the continuity corrected Pearson  $\chi^2$  test statistics. Panel A compares the median values of 952 EBA firms and 1006 Non-EBA firms in the unmatched sample. Panel B compares the 952 EBA 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
<i>Panel A: Unmatched Sample</i>							
EBA Firms	952	19.81	0.62	0.06	0.23	0.09	0.96
Non-EBA Firms	1,006	19.35	0.58	0.06	0.24	0.09	0.95
$\Delta$		0.45***	0.04***	0.00	0.00	0.00	0.00
<i>Panel B: Matched Sample</i>							
EBA Firms	952	19.81	0.62	0.06	0.23	0.09	0.96
Matched Control Group	951	19.65	0.60	0.06	0.23	0.09	0.94
$\Delta$		0.16*	0.02*	0.00	0.00	-0.01*	0.01***

**Table VII**  
**Firm-Level Outcomes**

Table VII presents the estimates of the *change in in the logarithm of total assets*, the *change in the logarithm of fixed assets*, and the *change in the logarithm of sales*. 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 EBA firms and control group firms respectively. We test for differences in means using the Welch two-sample t-test. The third row in each panel contains the unmatched difference-in-differences estimates comparing the treatment group of EBA firms to the control group. The fourth 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). 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	$\Delta\text{Log Total Assets}$ (1)	$\Delta\text{Log Fixed Assets}$ (2)	$\Delta\text{Log Sales}$ (3)
<i>Panel A: All Firms</i>			
EBA Firms: Before - After	0.07***	0.08***	0.11***
Non-EBA Firms: Before - After	0.11***	0.11***	0.14***
DID: Eba Firms vs. Control Group	-0.04***	-0.04*	-0.03
Matching Estimator ATT	-0.04**	-0.06***	-0.05**
Number of Observations	1958	1958	1958
<i>Panel B: Unlisted Firms</i>			
EBA Firms: Before - After	0.05**	0.05*	0.14***
Non-EBA Firms: Before - After	0.11***	0.12***	0.12***
DID: Eba Firms vs. Control Group	-0.06**	-0.07**	0.03
Matching Estimator ATT	-0.06***	-0.09***	-0.04
Number of Observations	1474	1474	1474
<i>Panel C: Listed Firms</i>			
EBA Firms: Before - After	0.13***	0.14***	0.05
Non-EBA Firms: Before - After	0.12***	0.10***	0.22***
DID: Eba Firms vs. Control Group	0.01	0.03	-0.17***
Matching Estimator ATT	0.02	0.03	-0.06
Number of Observations	484	484	484

**Table VIII**  
**Weakly and Strongly Capitalized Banks**

Table VIII presents the estimates of 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* 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 percent as of end of 2010 prior to the capital exercise. 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 EBA 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 unmatched difference-in-differences estimates comparing the treatment group of EBA banks to the control group. The fourth 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) using the baseline matching strategy. \*, \*\*, and \*\*\* indicate statistical significance at the 10%, 5%, and 1% level respectively.

Dependent Variable	$\Delta$ CT1 Ratio (1)	$\Delta$ Log CT1 (2)	$\Delta$ Log RWA (3)
<i>Panel A: Weakly Capitalized Banks</i>			
EBA Banks: Before - After	3.75***	0.21***	-0.18***
Control Group: Before - After	1.73***	0.20***	0.01
DID: EBA vs. Control Group	2.02***	0.01	-0.19***
Matching Estimator (ATT)	-0.09	-0.98***	-1.02***
Number of observations	22	22	22
<i>Panel B: Strongly Capitalized Banks</i>			
EBA Banks: Before - After	2.40***	0.16***	-0.04*
Control Group: Before - After	2.09***	0.19***	0.05
DID: EBA vs. Control Group	0.31	-0.03	-0.09***
Matching Estimator (ATT)	1.24*	0.01	-0.10**
Number of observations	26	26	26

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

Table IX presents the estimates of 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 using an alternative time window. The first and second row in each panel contain the differences in the outcome variables between the before (2009) and the after (2010) period for EBA 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 unmatched difference-in-differences estimates comparing the treatment group of EBA banks to the control group. The fourth 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) using the baseline matching strategy. \*, \*\*, and \*\*\* indicate statistical significance at the 10%, 5%, and 1% level respectively.

Dependent Variable	$\Delta$ CT1 Ratio (1)	$\Delta$ Log CT1 Capital (2)	$\Delta$ Log RWA (3)
EBA Banks: Before - After	0.53	0.06***	0.01
Control Group: Before - After	0.57	0.06**	0.03*
DID: EBA vs. Control Group	-0.04	0.00	-0.02
Matching Estimator (ATT)	0.17	-0.02	-0.06*
Number of observations	48	48	48

**Table X**  
**Bank-Level Regression Analysis**

Table X presents the estimation results of the difference-in-differences regression in equation (3). The variable *EBA* takes on the value 1 for the 48 EBA banks and 0 for the 145 Non-EBA banks in our baseline sample. The variable *After* takes on the value 1 for the years 2012 and 2013, and 0 for the years 2009 and 2010. In our favorite specification the paper includes bank fixed effects and country-year fixed effects. The dependent variable is the *core tier 1 ratio* in Panel A, the *logarithm of core tier 1 capital* in Panel B, and the *logarithm of risk-weighted assets* in Panel C. The variable *Large Banks* takes on the value 1 for all banks large than the median EBA bank in terms of pre-treatment levels of total assets, and 0 otherwise. The variable *Deposit Funding* takes on the value 1 for all banks with a larger than median deposit share of total assets, and 0 otherwise. The variable *GIIPS* takes on the value 1 for banks from Greece, Ireland, Italy, Portugal, and Spain, and 0 otherwise. Standard errors are clustered at the bank level. \*, \*\*, and \*\*\* indicate statistical significance at the 10%, 5%, and 1% level respectively.

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<i>Panel A: Core Tier 1 Ratio</i>					
	(1)	(2)	(3)	(4)	(5)
EBA $\times$ After	1.40*** (0.37)	1.53*** (0.34)	1.61*** (0.38)	1.66*** (0.37)	1.42*** (0.40)
Large Banks $\times$ After			-0.15 (0.49)		
Deposit Funding $\times$ After				0.44 (0.38)	
EBA $\times$ After $\times$ GIIPS					0.41 (0.80)
Bank Controls	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES
Year FE	YES				
Country $\times$ Year FE		YES	YES	YES	YES
EBA Banks	48	48	48	48	48
Non-EBA Banks	145	145	145	145	145
Observations	749	749	749	749	749

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Table X (cont.)

<i>Panel B: Log Core Tier 1 Capital</i>					
	(1)	(2)	(3)	(4)	(5)
EBA $\times$ After	0.05 (0.03)	0.05 (0.03)	0.04 (0.04)	0.06* (0.03)	0.04 (0.04)
Large Banks $\times$ After			0.01 (0.05)		
Deposit Funding $\times$ After				0.03 (0.03)	
EBA $\times$ After $\times$ GIIPS					0.04 (0.07)
Bank Controls	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES
Year FE	YES				
Country $\times$ Year FE		YES	YES	YES	YES
EBA Banks	48	48	48	48	48
Non-EBA Banks	145	145	145	145	145
Observations	744	744	744	744	744
<i>Panel C: Log Risk-Weighted Assets</i>					
EBA $\times$ After	-0.11*** (0.03)	-0.11*** (0.03)	-0.13*** (0.04)	-0.11*** (0.03)	-0.09*** (0.03)
Large Banks $\times$ After			0.04 (0.05)		
Deposit Funding $\times$ After				0.02 (0.03)	
EBA $\times$ After $\times$ GIIPS					-0.08 (0.07)
Bank Controls	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES
Year FE	YES				
Country $\times$ Year FE		YES	YES	YES	YES
EBA Banks	48	48	48	48	48
Non-EBA Banks	145	145	145	145	145
Observations	749	749	749	749	749

**Table XI**  
**Syndicated Lending: Extensive Margin**

Table XI presents the estimation results of the extensive margin regression in equation (4). Columns (1)-(3) present the results whether banks stopped lending to firm clusters after the capital exercise. The variable *Exit* takes the value of 1 if bank *b* in country *i* stops lending to firm cluster *j* after the EBA capital exercise, and 0 otherwise. Columns (1)-(3) present the results whether banks started lending to firm clusters after the capital exercise. The variable *Entry* takes the value of 1 if bank *b* in country *i* stops lending to firm cluster *j* after the EBA capital exercise, and 0 otherwise. The variable *EBA Bank* takes on the value 1 for EBA banks in the extensive margin sample, and 0 otherwise. Bank controls include the logarithm of 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, as of end of 2010. 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)
EBA Bank	-0.02 (0.02)	0.04 (0.04)	0.03 (0.03)	-0.11*** (0.03)	-0.03 (0.03)	-0.02 (0.03)
Bank Country FE	YES	YES	YES	YES	YES	YES
Bank Controls		YES	YES		YES	YES
Borrower Country x SIC FE			YES			YES
Treatment Banks	45	45	45	45	45	45
Control Group Banks	45	45	45	50	50	50
Adjusted $R^2$	0.01	0.02	0.23	0.07	0.08	0.28
Observations	2,439	2,439	2,439	2,469	2,469	2,469



**Table XII**  
**Firm-Level Regression Analysis**

Table XII presents the estimation results of the regression in equation (5). The variable *EBA Borrowing Share* is the share of borrowing in the syndicated loan market obtained by firm  $j$  from EBA banks in the period prior to the capital exercise. In our preferred specification the paper includes firm-level control variables (i.e., log total assets, tangibility, cash flow over total assets, net worth, EBITDA over total assets, and leverage), firm country fixed effects  $\eta_c$ , and industry fixed effects  $\eta_i$ . The firm outcome variable 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
<i>Panel A: <math>\Delta</math> Log Total Assets</i>						
EBA Borrowing Share	-0.09*** (0.02)	-0.07*** (0.02)	-0.08*** (0.02)	-0.08*** (0.02)	-0.09*** (0.03)	-0.02 (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
<i>Panel B: <math>\Delta</math> Log Fixed Assets</i>						
EBA Borrowing Share	-0.13*** (0.03)	-0.10*** (0.03)	-0.10*** (0.03)	-0.10*** (0.03)	-0.13*** (0.03)	-0.0 (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
<i>Panel C: <math>\Delta</math> Log Sales</i>						
EBA Borrowing Share	-0.08*** (0.03)	-0.08*** (0.03)	-0.09*** (0.03)	-0.07* (0.03)	-0.08** (0.04)	-0.14 (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

**Table XIII**  
**EBA Bank Sample**

Table XIII lists all 61 EBA 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	✓
HSB 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	✓
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	✓

**Table XIII (cont.)**

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 XIV**  
**Variable Definitions**

Table XIV 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 database, and all firm-level variables in Panel C are obtained from Bureau van Dijk's Amadeus Financials database.

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*Panel A: Bank-Level Variables*

<b>Variable</b>	<b>Definition (SNL Items)</b>
Core Tier 1 Capital	220292
Risk-Weighted Assets	133174
Core Tier 1 Ratio	220293
Total Assets	132264
Total Deposits	132288
Total Deposits / Total Assets	132288 / 132264
Customer Loans	132214
Customer Loans / Total Assets	132214 / 132264
Net Interest Income / Operating Revenue	133246
Net Income	132740
Net Income / Total Assets	132740 / 132264
Risk-Weighted Assets / Total Assets	227010
Loan Loss Reserves / Customer Loans	256782
Total Securities	132191
Large Banks	= 1 if bank $i$ is larger than the median EBA bank, and 0 otherwise.
Deposit Funding	= 1 if bank $i$ has a larger than median deposit share of total assets, and 0 otherwise.
GIIPS	= 1 if bank $i$ is located in Greece, Italy, Ireland, Portugal or Spain, and 0 otherwise.

*Panel B: Loan-Level Variables*

<b>Variable</b>	<b>Definition</b>
Loan exposure	Outstanding volume of syndicated loans of bank $b$ in country $i$ to firm cluster $j$ in quarter $t$
Exit	= 1 if bank $b$ in country $i$ starts lending to firm cluster $j$ after the EBA capital exercise, and 0 otherwise
Entry	= 1 if bank $b$ in country $i$ stops lending to firm cluster $j$ after the EBA capital exercise, and 0 otherwise

**Table XIV (cont.)**

*Panel C: Firm-Level Variables*

<b>Variable</b>	<b>Definition (Amadeus Variable Names)</b>
Total Assets	TOAS
Fixed Assets	FIAS
Sales	TURN
Tangibility	FIAS / TOAS
Cash Flow	CF
Cash Flow / Total Assets	CF / TOAS
Total Shareholder Funds	TSHF
Current Liabilities	CULI
Non-Current Liabilities	NCLI
Cash	CASH
Net Worth	(TSHF-CULI-NCLI-CASH)/TOAS
EBITDA	EBTA
EBITDA / Total Assets	EBTA / TOAS
Shareholder Funds: Capital	CAPI
Leverage	(TOAS-CAPI)/TOAS



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