Do Higher Bank Capital Requirements Really Decrease Systemic Risk?

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ABSTRACT

We study the effects of higher capital requirements on systemic risk in the European banking sector. We identify the impact of more stringent capital requirements on systemic risk by using a difference-in-differences approach that exploits the unique setting of the 2011 EBA capital exercise. Our results are sobering as we find an individual bank's contribution to systemic fragility to decrease only marginally after the introduction of higher capital requirements. Moreover, this decrease in systemic risk is transitory and vanishes two years after the EBA capital exercise. At the same time, a bank's vulnerability to market shocks increases greatly as the capital exercise red-flags banks whose capital buffer is perceived as being too low.

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1 Introduction

Since the financial crisis of 2007-2009, central bankers and regulators have discussed various ways to improve the regulation and supervision of financial institutions to enhance financial stability. At the heart of almost all of these initiatives (with Basel III being the most recent one) are efforts to strengthen regulatory capital buffers of banks. While the vast majority of studies in financial economics unanimously demands that banks should be obligated to operate with more capital (see, e.g., Kashyap et al., 2008; Admati et al., 2011; Hart and Zingales, 2011; BIS, 2012), reliable empirical evidence on the efficacy of higher capital requirements in reducing systemic risk is inconclusive to nonexistent. Most recently, empirical work by Jordà et al. (2017) on historical capital ratios in advanced economies between 1870 and 2013 outright questions the ability of higher capital to prevent financial crises in general (though it might help economies to recover from banking crises). In this paper, we fill this gap in the literature by empirically addressing the question whether higher capital requirements lead to a significant decrease in the systemic importance of banks. As our paper analyzes perhaps the most pivotal instrument regulators have at their disposal to prevent the next financial crisis, our findings should be of interest not only to financial economists but also to policymakers.

The empirical analysis of the relation between a bank's regulatory capital and its (systemic) risk is plagued by the notorious endogeneity between the two. Perhaps not surprisingly, the available empirical evidence on the effects of capital regulation on bank risk is mixed at best: While studies by, e.g., Barth et al. (2004) and Laeven and Levine (2009) find that more stringent (capital) regulation and supervision attenuate bank risk-taking, the former study also finds that a country's capital stringency has only little power for explaining banking crises. Similarly, evidence on the collateral damage of higher capital requirements on bank performance and lending is also ambiguous. Although studies by Berger and Bouwman (2013), Demirgüç-Kunt et al. (2013), and Jiménez et al. (2017) find a positive effect of capital and (countercyclical) capital requirements on bank performance, the recent study by Gropp et al. (2016) shows that banks fulfill tightened capital requirements by reducing their credit supply. Yet, no study so far has tried to identify the causal effect of higher capital requirements on its primary intended targets: an individual bank's systemic importance and its risk.[1]

To address this highly policy-relevant question and the challenges related to the identification of the causal relation between capital regulation and financial stability, we exploit the 2011 capital exercise conducted by the European Banking Authority (EBA) that required only a given country's largest banks to increase their core tier 1 ratio to 9%. More precisely, banks were included in the EBA capital exercise based not on their absolute but their *relative* size in their respective home country's banking sector. As a result, the EBA capital exercise and its exogenous selection of banks constitute a near-perfect quasi-experimental setting to overcome the difficulties that have so far prevented a sound empirical analysis into the effectiveness of a regulator's perhaps most important instrument.

We employ a difference-in-differences matching estimation approach and compare banks that participated in the EBA capital exercise ("participants") with matched non-participating but otherwise similar banks ("non-participants"). In doing so, we follow Gropp et al. (2016) who use a similar identification strategy but solely concentrate on the collateral damage of the EBA capital exercise, i.e., its unintended effect on lending. In particular, we first test their result that participants did indeed increase their capital ratios significantly relative to non-participants but then focus on the effects of these increases on bank risk. To measure a bank's systemic risk, we use the bank's Marginal Expected Shortfall (MES), ΔCoVaR, and SRISK (see Acharya et al., 2017; Adrian and Brunnermeier, 2016; Brownlees and Engle, 2017).

The results that we find are sobering and cast significant doubt on the cost-benefit ratio of increases in capital requirements. Despite the fact that banks that participated in the EBA capital exercise mildly increased their core tier 1 ratios compared to the control group of matching non-participating banks, the differences in the banks' contribution to systemic risk changed only marginally around the capital exercise. On the plus side, we do find a (weakly) significant improvement in systemic risk of participating banks as measured by their ΔCoVaR. However, this

[1]For further work on the unintended consequences of regulation, see, e.g. Adrian and Ashcraft (2012) and Acharya et al. (2013).

decrease in the banks' systemic risk contribution is fallacious at best. First, the stabilizing effect of the increase in capital requirements was transitory with the average ΔCoVaR of participants decreasing again one year after the exercise. Second, banks that did not participate in the EBA capital exercise continuously decreased their systemic risk contribution as well and surpassed participating banks just two years after the exercise. At the same time, we cannot confirm the change in banks' systemic risk when switching to SRISK as a measure of a bank's capital shortfall. Even more importantly, and a possible explanation for these conflicting results is that the capital exercise led to a significant increase in the exposure of participating banks' equity as measured by their MES. The stocks of banks who had to increase their capital ratio subsequently had a higher risk of losses conditional on the sector being in distress. We show that this increase in systemic risk exposure can mainly be attributed to the signaling effect of the EBA capital exercise which red-flagged participating banks as undercapitalized.

Our paper is related to several previous studies in the banking literature yet contains a distinctive new contribution. First, our paper is most closely related to the works by Mésonnier and Monks (2015) and Gropp et al. (2016) who all exploit the 2011 EBA capital exercise as a quasi-experiment to study the effect of higher capital requirements on lending and subsequent firm growth. In contrast to their papers, however, we study the efficacy of the regulation itself rather than its unintended collateral damage in terms of lending contractions. Second, our paper is also related to several other studies that examine the effect of capital regulation on bank lending.[2] All of these studies document that banks almost naturally respond to tighter capital requirements by reducing their risk-weighted assets, i.e., cutting down lending. None of these studies, however, analyze the question whether these reductions in lending also effectively reduce overall bank risk and ultimately the fragility of the financial sector as a whole.[3]

[2]The relation between higher capital requirements and credit crunches has been examined by (amongst others) Berger and Udell (1994), Peek and Rosengren (1997), Kashyap et al. (2008), Fraisse et al. (2015), Aiyar et al. (2014a,b, 2016), Célérier et al. (2016), Kisin and Manela (2016), and Jiménez et al. (2017).

[3]An overall positive effect of capital regulation on bank risk is of course not a given. Although regulators and theoretical models by Furlong and Keeley (1989, 1990), and Rochet (1992) agree that capital requirements can be effective in curbing bank risk-taking, the opposite view is taken by Koehn and Santomero (1980) and Kim and Santomero (1988) who show theoretically that by reducing bank charter value, higher capital requirements can even increase the default probabilities of banks.

Moreover, our paper is related to studies that analyze the changes in the perception of a bank's risk by investors and creditors. In this strand of literature, a small but growing number of studies have documented the effects of bailouts, implicit guarantees, and banks' systemic importance on the banks' equity and debt.[4] For example, Oliveira et al. (2014) find empirical evidence for a run of depositors in Brazil to large banks that is better explained by the perception of a too-big-to-fail policy than by bank fundamentals. Similarly, Gandhi and Lustig (2015) uncover a size factor in the bank returns that is consistent with government guarantees shielding shareholders of large banks from default. In a related study, using out-of-the-money put options, Kelly et al. (2016) find that financial sector equity holders enjoyed a sizable government subsidy in the form of free insurance against a collapse in bank stock prices during the financial crisis. Our analysis complements these studies by documenting a negative effect of the forced increase in capital at EBA banks that can best be explained by the signalling effects of banks being publicly blacklisted as systemically important.

The policy implications of our findings are important and potentially far-reaching. The vast majority of studies on the real effects of capital requirements has unanimously documented the detrimental effects of higher capital requirements. All of these studies, however, are based on the assumption that capital regulation curbs an individual bank's risk-taking and subsequently systemic risk so that the side-effects (however grave they may be) become acceptable as the lesser of two evils. Our empirical results show that the positive effects of higher capital requirements on bank risk-taking and systemic risk are far smaller than one would expect. Moreover, our study reveals an additional negative side-effect of highly publicized increases in regulatory capital. Perhaps not entirely unintendedly, banks that are disciplined by regulators by appearing on their SIFI blacklists suffer heavy losses on their equity's market value. However, the magnitude of the losses experienced by banks participating in the EBA capital exercise casts significant doubt on the proportionality of this disciplining instrument as it simultaneously increases the banks' exposure to systemic downturns.

[4] See, e.g., Berger and Roman (2015, 2017) and Berger et al. (2016) for several analyses into the distortive effects of the Troubled Assets Relief Program.

The remainder of the article proceeds as follows. In Section 2, we develop our empirical hypotheses. Section 3 describes the data and the empirical strategy that we use. Section 4 presents and discusses our main results as well as the results of additional robustness checks. Section 5 concludes the article.

2 Hypothesis development

In this section, we distill from the literature the different channels through which (changes in) regulatory capital requirements could affect the systemic relevance of banks. From these channels, we develop the hypotheses which we test in our empirical analysis. Our hypotheses examine the differential impact of macroprudential capital regulation on a bank's systemic relevance, measured on the one hand by its exposure to systemic risk in the financial sector, and on the other hand by the bank's own active contribution to market tail risk. Accordingly, we group the channels into those that are related 1) to a bank's systemic vulnerability and 2) to a bank's role as an active contributor to financial fragility.

2.1 Channels that affect a bank's systemic risk exposure

The first channel that we discuss is the ***Stigma vs. Safety Channel***. On the one hand, banks that are forced by regulators to increase their capital ratios could be perceived as riskier than they actually are. In other words, the stigma of undercapitalization caused by the inclusion in the EBA capital exercise could have decreased the trust of shareholders in the banks, scared away potential creditors and customers, and as a result could have weakened the banks' market position. In fact, bank managers seem to be quite concerned about the public stigma of requiring additional capital as underlined by the reluctance of bank managers to accept capital injections from governments during the financial crisis (see Hoshi and Kashyap, 2010). On the other hand, market participants could view EBA banks as safer as their capital buffer is increased regardless of their actual default risk. In this case, banks should ceteris paribus attract more clients/depositors as well as other sources of funding. Empirical evidence for this line of argumentation is found by Oliveira et al. (2014) who show that Brazilian depositors fled to larger and thus presumably safer banks during the financial crisis. Consequently, with a bank's deposits being safer from experiencing a run, its participation in the EBA capital exercise should decrease its exposure to market tail events.

Next, a bank's exposure to systemic risk could also be positively affected via the ***Capital Cushion Channel***. Several papers in the literature (see, e.g., Repullo, 2004; Von Thadden, 2004; Berger and Bouwman, 2013) stress the role of capital acting as a buffer against unexpected losses thereby decreasing a bank's default probability. Whether it be due to the direct mechanical effect of higher capital or due to the indirect effect higher capital has on the banks' screening and monitoring of borrowers (see, e.g., Holmstrom and Tirole, 1997; Coval and Thakor, 2005; Allen et al., 2011), higher capital requirements should lower a bank's vulnerability if hit by adverse shocks spilling over from the financial sector.

Moreover, increases in regulatory capital could also have a significant impact on a bank's systemic risk exposure via the ***Reduced Moral Hazard Channel***. A higher capital ratio, the public designation as a systemically important financial institution (SIFI), as well as the stronger scrutiny of supervisors could all reduce bank managers' incentives for excessive risk-taking (see, e.g., Kashyap et al., 2008; Admati et al., 2011; Hart and Zingales, 2011; Berger and Bouwman, 2013; Berger et al., 2016). As a result of the improved moral hazard problem and decreased risk-taking, participating banks should be less vulnerable to exogenous adverse shocks.

A bank's exposure to systemic risk could additionally be driven by changes in capital requirements via the ***Cost channel***. Banks that are forced to increase their regulatory capital need to either reduce their lending or to hastily issue equity amidst or after a crisis. In the latter scenario, the new equity will be more expensive than other sources of funds thus increasing the bank's cost of capital and deteriorating the bank's overall market position. The higher capital ratios will thus increase a bank's systemic vulnerability.

In summary, the inclusion of a bank in the EBA capital exercise could both be positively and negatively related to the bank's systemic risk exposure, and we accordingly test the following opposing hypotheses:

H1a: Banks that were included in the EBA capital exercise, ceteris paribus, have a higher exposure to systemic risk.

vs.

H1b: Banks that were included in the EBA capital exercise, ceteris paribus, have a lower exposure to systemic risk.

2.2 Channels that affect a bank's systemic risk contribution

Similarly to a bank's systemic risk exposure, a bank's *contribution* to systemic fragility could be affected by changes in regulatory capital via the ***Stigma vs. safety channel***. The view of market participants that a bank is undercapitalized and in need of assistance could lead to a drop in both the supply and demand for loans as well as a higher vulnerability of the bank's deposits to runs. Perhaps even more likely, the bank's wholesale partners in the interbank and OTC markets could react to this stigma by cutting business ties. While a cut in interconnections between banks could favourably affect systemic risk, this stabilizing effect will indubitably be canceled out by the increased fragility of the bank's funding structure. Alternatively, the perception of the bank as safer and more tightly supervised could attract both more and less risky loan applicants as well as better funding possibilities in the interbank market. The ensuing decrease in portfolio risk and the improvement in the fragility of the bank's funding could then lead to a lower contribution to systemic risk. Closely related to this line of argumentation, banks could also have a lower systemic relevance via the ***Reduced Moral Hazard Channel*** as the tighter supervision of EBA banks could discourage managers from engaging in excessive risk-taking and thus significantly reduce the systemic risk emanating from these banks in the process.

Next, the regulator's decision to force certain banks to increase their capital ratios could also increase moral hazard concerns and lead to a higher contribution to systemic risk via the ***Too-Big-To-Fail Channel***. The inclusion of banks in the EBA capital exercise based on a bank's relative size practically yielded a list of banks that were considered to be systemically relevant by the regulator.

For these banks, the designation as a SIFI should have increased the perceived probability of a government bailout in case the bank approached its default barrier. As shown by Dam and Koetter (2012), such an increase in bailout probabilities could lead bank managers to take on excessive risks which could in turn destabilize the financial system.

Finally, increases in regulatory capital could coincide with changes in a bank's contribution to systemic risk via the ***Market Power Channel***. First, mandatory increases in regulatory capital could lead to both increases or decreases in the market power of a single bank as well as changes in overall competition in the banking sector. For example, as described above, EBA banks could attract more customers via the *Safety channel* or directly use the additional capital to take market shares away from competitors (see, e.g. Fudenberg and Tirole, 1986). In contrast to this argumentation, banks that face higher capital requirements could increase capital ratios by simply reducing their lending which in turn would decrease the bank's market share. Additionally, the stigma of undercapitalization could further drive loan applicants and depositors to competitors. Second, the expected effect of a change in overall competition in the banking sector on financial stability remains theoretically and empirically unclear. On the one hand, advocates of the *concentration-stability hypothesis* argue that monopolistic banks possess higher capital cushions (see Allen and Gale, 2000, 2004), have less incentives to take on excessive risks due to higher charter values (see, e.g., Matutes and Vives, 2000), and have a better loan portfolio diversification (see Diamond, 1984) which all lead to a stabilization of the financial sector. In contrast, the *concentration-fragility hypothesis* posits that competition and stability are positively correlated as more monopolistic banks are more likely to originate risky loans (see, e.g., Caminal and Matutes, 2002) and as joint defaults of customers become more likely in case banks merge (see Boyd and De Nicolò, 2006).[5] In summary, we have no expectation concerning the direction of the impact of competition on financial stability.

As with the expected effect on systemic vulnerability, mandatory changes in regulatory capital can thus have both a stabilizing or a destabilizing effect on the financial system. We therefore test

[5]The empirical evidence on both competing hypotheses is also divided. While studies by Carbo-Valverde et al. (2012) and Schaeck et al. (2009) confirm the *concentration-fragility* view, the opposite result is found by Beck et al. (2006b,a) who find that less competitive bank sectors are more stable.

the following alternative hypotheses:

H2a: Banks that were included in the EBA capital exercise, ceteris paribus, have a higher contribution to systemic risk.

vs.

H2b: Banks that were included in the EBA capital exercise, ceteris paribus, have a lower contribution to systemic risk.

3 Data and empirical strategy

This section defines the different measures of bank risk we employ as dependent variables in our analysis and describes the construction of our sample. Moreover, we outline the procedure we use for matching EBA-banks to non-EBA banks using propensity scores.

3.1 Measures of bank risk

The focus of our paper lies on an in-depth analysis of the effects changes in capital requirements have on a bank's individual and systemic risk profile. Concerning the latter, we follow the literature (see, e.g., Zhang et al., 2015; Acharya et al., 2017) and distinguish between a bank's passive *systemic risk exposure* and its active *contribution to systemic risk*. We measure a bank's systemic risk exposure by its MES (see Acharya et al., 2017; Brownlees and Engle, 2017) which is defined as the return on a bank's equity during tail events of the financial sector. To proxy for the European financial sector, we use the MSCI Europe Banks Index (*Datastream* code M2URB2$). We follow the estimation model of Brownlees and Engle (2017) and employ the dynamic "long-run"-MES as a proxy for a bank's exposure to such systemic tail events. Daily MES estimates for all trading days within a year are computed using TARCH and Dynamic Conditional Correlation (DCC) specifications (see Rabemananjara and Zakoïan, 1993; Engle, 2002).

Additionally, we measure the (intended) effects of tighter capital requirements on a bank's contribution to financial fragility by looking at a bank's ΔCoVaR (see Adrian and Brunnermeier, 2016). In contrast to the MES, the (conditional) ΔCoVaR measures changes in the financial system's Value-at-Risk (VaR) in case an individual bank's VaR shifts from its median state to the extreme left tail (i.e., when the bank is in distress).[6]

We complement both systemic risk measures by using the (absolute and relative) SRISK measure of Brownlees and Engle (2017) as a proxy for a bank's potential capital shortfall during a crisis. More precisely, SRISK is the capital that a bank is expected to need conditional on a crisis:

$$\text{SRISK}_{j,t} = \text{Equity}_{j,t}\left[k \cdot \text{Leverage}_{j,t} + (1-k)\text{LRMES}_{j,t} - 1\right]. \tag{1}$$

SRISK is a function of a bank's size proxied by its absolute amount of equity, the bank's leverage ratio, and its long run Marginal Expected Shortfall (LRMES) which proxies for the expected decrease in equity value given a systemic crisis of the financial market. For each bank-year, we take the mean daily SRISK estimate to proxy for this bank-year's annual SRISK estimate.

Finally, in our later analyses, we follow Laeven and Levine (2009) and Anginer et al. (2014) and employ a bank's stock return volatility and its z-score as proxies for the bank's individual default risk.

3.2 Sample construction

Our primary sample consists of all publicly traded European banks included in the active and dead firm list in *Thomson Reuters Financial Datastream*. We consider a bank's country to be the country of its primary listing. All secondary listings and nonprimary issues are excluded. Our initial sample includes 365 European banks from 32 countries. While daily share price data are retrieved from *Thomson Reuters Financial Datastream*, financial accounting data are taken from the *Bankscope* database. To ensure the comparability within our European banks, all stock market and accounting data are collected in European Euro to minimize a possible bias in our results

[6]As we focus on the European banking market, we do not use the state variables based on US-level data as proposed by Adrian and Brunnermeier (2016) to estimate ΔCoVaR. Instead, we consider appropriate European state variables, i.e., the change in the Euro yield curve, the change between the ten-year Euro area yield rate and the three-month Euro interest rate, the Euro Stoxx 50 return, real estate returns in excess of the Euro Stoxx 50 equity market, the short-term Treasury Bill Eurodollar spread and the change in the credit spread VSTOXX.

stemming from currency risk. To rule out any possible survivorship bias, we allow banks to default over our entire sample period. The European Banking Authority (EBA) raised capital requirements for a subset of European banks, which we define as our treatment group ("EBA banks" or simply "participants"). Banks that were not affected by the EBA's capital requirements form the control group (or "non-EBA banks"). The EBA considered banks in the capital exercise based not on their absolute but their relative size in their respective home country's banking sector. This identification leaves us with a total of 56 EBA banks and 309 non-EBA banks.[7] Italy is the country with the highest total number of EBA-banks (9). The countries Hungary, Finland, Cyprus and Portugal each only have one EBA-bank.

For the estimation of our systemic risk measures, e.g., MES or ΔCoVaR, we require daily share price data to be available for the full year from *Thomson Reuters Financial Datastream*. Moreover, to include a bank in our sample, we require lagged annual balance sheet data from *Bankscope* not to be missing. Due to the fact that *Datastream* suffers from well-known minor data errors with regard to stock prices, we perform several screening-procedures as proposed by Ince and Porter (2006) on the daily returns on banks' stock prices. First, a minimum share price of $1 is required for a bank to be included in our sample. Second, any return above 300 percent that is reversed within one month is treated as missing. Also, we exclude a bank, if the number of zero return days is more than 80 percent in a given month of that year (see, e.g., Hou et al. (2011)). Non-trading days are excluded from our sample, if 90 percent or more of the stocks listed on a given exchange have a return equal to zero.

We also control for a possible selection bias stemming from bank opacity by employing a two-step approach. First, we control for banks omitted from our analysis if data we use from *Datastream* or *Bankscope* is only incomplete and for which key data items are available. In a second step, we check if we can find stock market data and balance sheet data from the respective bank from a publicly data source if, e.g., *Datastream* does not provide any data. This approach enables us to rule out any possible selection bias resulting from bank opacity.

[7]Note that we only employ listed banks in our analysis, which lowers the total of 61 EBA banks to 56 (see Gropp et al., 2016).

Additionally, we control for any distorting effect due to bank mergers in our sample.[8] To rule out any biasing influence of bank mergers, we exclude both the acquirer and the target in the year in which a merger took place. The merging banks are identified by manually searching the *Thomson One Banker Database*.

Our final sample is comprised of 3,285 bank-year observations for the period of 2006-2014. The distribution of bank-years across our sample of European banks shows that Ukraine, Switzerland and Norway have the largest number of bank-year observations, while Luxembourg and Lithuania have the smallest number of bank-year observations. For the year 2010, i.e. the year before the EBA capital exercise, our sample contains 365 bank observations.

3.3 Matching Procedure

We employ a matching approach that attempts to match each EBA bank in our sample to a similar non-EBA bank. This matching procedure allows us to control if EBA banks and non-EBA banks that are not subject to higher capital requirements differ in their level of systemic risk after 2011. To be precise, we follow Drucker and Puri (2005), Bartram et al. (2011), and Bartram et al. (2012) and employ propensity score (p-score) matching to compare banks along multiple dimensions simultaneously.

First, we use bank size as proxied by the natural logarithm of a bank's total assets. The motivation behind the choice of this bank characteristic for matching is evident. On the one hand, the EBA identified EBA-banks if their total assets cover at least 50% of the cumulative banks' total assets of each bank's country banking sector. As this identification of EBA-banks is based upon the total national level of bank assets, the smallest EBA-bank in our sample is the SKJERN Bank in Denmark with €0.73 billion in total assets while the largest EBA-bank is BNP Paribas with €1,998.16 billion in total assets. For our group of non-EBA banks, however, the smallest non-EBA bank is BOS in Poland with €3.83 bn while Credit Suisse Group in Switzerland with

[8] In this context several studies analyzed the effect of bank mergers on banks' systemic risk. For instance, De Nicoló and Kwast (2002) argue that bank mergers increase banks' systemic risk level. Also, Weiß et al. (2014) find evidence for a significant increase in the merging banks' contribution to systemic risk following mergers.

€822.00 billion in total assets represents the largest non-EBA bank in our sample. On the other hand, the Basel Committee on Banking Supervision (2013) identified, among other factors, bank size to be a main driver of systemic risk. Hence, if a bank's systemic risk level is determined by its size, matching pairs of EBA and non-EBA banks should not differ in their systemic relevance. To rule out any concern that our results are determined by other factors than bank's size, we consider the loan to total assets ratio, the deposit to total asset ratio, net interest margin, net income to total assets and a bank's tier 1 capital ratio as further matching covariates in 2010. This allows us to match banks based on their business model, their profitability, and their capital ratio before the EBA capital exercise.

Matching based on propensity scores is done by first estimating a logit regression of an indicator function of membership to the sample of EBA banks on our set of bank characteristics. In the second step, EBA and non-EBA banks are matched using the predicted values from the first step by minimizing the difference between the estimated propensity scores of EBA and non-EBA banks following the nearest neighbor technique. Due to data availability, especially for listed banks, we allow matching of EBA and non-EBA banks across different European countries. For the propensity score matching to yield unbiased results, variables used for matching and systemic risk measures must not be determined simultaneously. To control for the possibility that our matching variables are determined at the same time as the banks' MES, ΔCoVaR or SRISK, we employ lagged values of every of the covariates. To improve the quality of our matching, EBA banks are matched to non-EBA banks with replacement and matching is done for the year 2010, which represents the year before EBA announced capital requirement exercise.

3.4 Difference-in-difference estimation

We use the EBA exercise in 2011 as a quasi-natural experiment and estimate a difference-in-difference model. Due to the exogenous nature of the EBA bank designations, we are able to capture the effect of higher capital requirements on both banks' exposure and contribution to systemic risk. Banks that are affected by the increase of capital levels to (at least) 9%, which was due in June 2012, belong to the treatment group in this difference-in-difference approach and the collection of other (matched) banks serve as control group. We follow Gropp et al. (2016) and separate our data into pre- and post-treatment periods and run cross-sectional regressions.[9] As our sample consists of annual observations, we define the pre-treatment period as 2010 and the post-treatment period is (end of) 2012, 2013, or 2014.[10] We then run regressions of the form

$$\Delta \mathrm{Y}_i = \alpha + \nu_j + \beta \cdot \mathrm{EBA}_i + \Theta \cdot \text{BANK CONTROLS}_{i,2010} + \varepsilon_i, \tag{2}$$

where the dependent variable $\Delta \mathrm{Y}_i$ is the absolute change in the chosen systemic risk measure from 2010 to either 2012, 2013, or 2014. This difference is regressed on EBA_i, which is a dummy variable that takes on the value of one if the bank is an "EBA bank", i.e., it participated in the capital exercise in 2011. Further, we include bank control variables as of 2010. All regressions are performed using robust standard errors.

In order to account for differences in European banking markets across countries, we include country-fixed effects ν_j in all our regressions. Thus, the coefficient estimate of β represents the within-country effect of the EBA designation on systemic risk and not just captures differences in size or other covariates because of country differences.

4 Empirical Results

In this section, we present the empirical results of our main analysis of the efficacy of the 2011 EBA capital exercise in reducing the exposure and contribution of banks to systemic fragility. We then continue to a detailed investigation into the driving forces behind the changes of systemic risk induced by the regulators' intervention.

[9] See also Khwaja and Mian (2008) and Bertrand et al. (2004) for a similar approach.

[10] In later analyses, we also estimate panel regressions that employ a symmetric time period around the EBA capital exercise in 2011 and use data from 2006 to 2014.

4.1 Descriptive Statistics

We first present and discuss descriptive statistics for our sample of European banks in Table I. Descriptive statistics are presented separately for both our full sample running from 2006 to 2014 (Panel A) and for the year 2010, i.e., the year before the EBA capital exercise (Panel B).

[Place Table I about here.]

In both Panels of Table I, we first present the summary statistics for the systemic risk measures, i.e., the banks' ΔCoVaR as a measure of their contribution to systemic risk, the banks' MES as a proxy for their exposure to sectoral fragility, and the banks' SRISK as a measure of each bank's average capital shortfall needed in case of a financial crisis. We also scale the estimates of SRISK by the banks' total assets to analyze a bank's per dollar systemic risk and to make the systemic risk of our sample banks more comparable. Additionally, we also provide summary statistics for selected bank-specific variables that we use for our matching procedure.

Panel A of Table I shows that the average contribution to systemic risk and hence to the instability of the financial market is just 0.2% across our full sample period. The average exposure to systemic risk as measured by the MES is 2.5%. Turning to the SRISK of banks in our sample, we can observe an average SRISK of 9.3 bn Euro. This measure reflects a bank's combined liabilities and exposure to shocks in equity prices. While the minimum SRISK for a bank in our entire sample is 0.002 bn Euro, the maximum SRISK is 142.240 bn Euro. To make banks of different size levels more comparable, we divide each bank's SRISK estimate by the bank's total assets. From the reported results we can see that the estimated figures for the banks' SRISK per total asset ratios show only little variation with ratios being between 0.041% and a maximum SRISK per total asset ratio of 0.055%. For our full sample, the average and maximum SRISK per total asset ratios coincide with 0.055%. Turning to the bank-specific variables, we can see that banks' average deposit to total asset ratio is 13.4% while the mean loan to total assets ratio is 62%. The largest bank in our sample has total assets of 2,586.70 bn Euro and the smallest bank 0.013 bn Euro with the average bank size being 109.67 bn Euro. When looking at the banks' ROA as a performance proxy, we can see that on average banks had a small but positive ROA of 0.5%.

Panel B of Table I provides summary statistics for the pre-treatment year, 2010, i.e. the year before the EBA put in place higher capital requirements for the set of presumably more fragile banks. Comparing the results of Panel B with Panel A, we can observe that banks in 2010 contributed slightly less to systemic risk and had a lower systemic risk exposure. More precisely, banks' average ΔCoVaR was 0.1% and the average MES was 1.8%. However, we find that the average SRISK per total assets ratio is the same as for the entire period in Panel A. The bank-specific variables illustrate that on average the deposit to total asset ratio, the loan to total asset ratio, and the ROA are similar to those for our full sample in the period from 2006-2014. Banks, on average, were larger in 2010 than in in our full sample period with mean total assets of 115.76 bil. Euro. Finally, banks were, on average, well capitalized with a mean tier 1 capital ratio of 13.79%. These first results from the descriptive statistics of our sample do no present any evidence of sector-wide systemic risk, a result which is not surprising given the fact that our full sample includes both participating and non-participating banks. To get a first impression of the differential effect of the EBA capital exercise on both our treatment and control groups, we analyze graphically the evolution of the systemic risk measures for both the treatment and control group in Figure 1.

[Place Figure 1 about here.]

Panel A of Figure 1 illustrates the time evolution of matched banks' exposure to systemic risk, as measured by the banks' MES during our sample period. EBA and non-EBA banks are matched based on their total assets, their loan to total assets ratio, their deposit to total asset ratio, net interest margin, net income to total assets and tier 1 capital ratio at the end of year 2010 and we compare the banks' exposure to systemic risk for 2006 through 2014. First, we observe a spike in both the participants' and non-participants' exposure to financial fragility during the years of the financial crisis starting in 2007. The average MES of banks' spiked up from 2% to almost 8% for EBA banks and 5% for non-participating banks. After the crisis, the systemic risk exposure of both groups decreased significantly to little more than their average pre-crisis levels. In 2010 and 2011, banks in the treatment and control groups did not only exhibit a parallel trend but an almost identical time evolution with average MES estimates being close to 4%. After the EBA capital exercise in 2011, average MES estimates diverge extremely. While the average exposure to systemic risk increases sharply to almost 11% for banks in the treatment group, the opposite result can be seen for non-participating banks. The steep increase in average MES is reversed for banks in the EBA treatment group one year after the exercise but the average MES stays well above the corresponding average MES of the non-participating banks. This is in part due to the fact that the MES continues to decrease for non-participating banks, on average, two years after the EBA capital exercise. Finally, in 2014, both bank groups again have similar levels of systemic risk exposure.

In Panel B of Figure 1, we show the corresponding time evolution of EBA and non-EBA banks' systemic risk contribution as measured by their average ΔCoVaR. Again, we can observe that both lines exhibit exactly the same behaviour at the start of our sample period and a parallel trend during the years prior to the EBA capital exercise. While both bank groups, on average, contributed almost in the same manner to systemic risk in 2006 and 2007, the average ΔCoVaR of EBA banks decreased slightly during the financial crisis. Looking at the average estimates in 2011, participating banks had an approx. 0.5% lower ΔCoVaR than non-participants and did thus contribute more strongly to systemic fragility. However, the difference in average ΔCoVaR that we find is only marginally economically significant. Focusing on the effect of the EBA capital exercise, the plot in Panel B of Figure 1 shows clearly that the systemic risk contribution of participants dropped as their mean ΔCoVaR increased from -1% to an average of close to 0%. At the same time, however, the mean contribution to systemic risk of banks that did not participate in the EBA capital exercise also increased, though not as sharply as for the EBA banks, thus leading to an overall difference-in-differences that is only slightly significant. The positive impact of the EBA capital exercise on participating banks, however, is again reversed in 2013 with mean ΔCoVaR decreasing again. For non-participating banks, the decrease in banks' mean systemic risk contribution further continues in 2013. Both trends persist until the end of our sample in 2014. Consequently, the EBA capital exercise appears to have improved the systemic risk of EBA banks although the positive effect is partly reversed immediately after the increase in capital requirements. More astonishingly, an even larger improvement can be seen for the control group of non-participating banks thus questioning the causality of the effect seen for EBA banks.

4.2 Mean differences of participating and non-participating banks

To start our main investigation, we first present mean estimates of the four systemic risk measures we use for the differences across both the control and treatment group as well as across time (i.e., the difference-in-differences). The results of these estimated mean differences are presented in Table II. In each Panel of the table, we present the differences in the systemic risk measures for EBA banks, the matched control group banks, and the differences in means of both groups between the before (2010) and after period (2012, 2013 and 2014), in regard to the EBA capital exercise in 2011, respectively.

[Place Table II about here.]

Panel A of Table II compares the systemic risk measures of the treatment and control group banks before and after the increase in capital requirements. The results indicate that both EBA and non-EBA banks experienced significant increases in their systemic risk exposure, as measured by the MES. More precisely, the increase in MES for EBA banks is 9.14% and 2.62% for non-EBA banks, respectively. Also, the difference-in-differences between both groups is 6.52% and thus, in addition to being statistically significant at the 1% level, highly economically significant as well. Turning to the corresponding estimates for ΔCoVaR, we can see that neither the EBA banks nor the control group of non-participating banks decreased their contribution to the instability of the financial system significantly. The same result can be seen when looking at SRISK as a measure of the banks' capital shortfall in times of financial crisis. Standardizing the SRISK estimates by the banks' total assets does not significantly change the finding that the contribution of banks to systemic risk did not change between 2010 and 2012.

In Panels B and C of Table II, we analyze the persistence of the effects on participating banks two and three years after the change in regulation. As seen before in Figure 1, the changes in both the EBA banks' exposure to system-wide risk as well as their active contribution to systemic instability are in part reversed two years after the change in capital regulation and are no longer significant when looking at the difference-in-differences between 2010 and 2014. The results thus clearly show that the surge in the exposure to systemic risk experienced by participating, though dramatic in size, was only temporary with the effect vanishing two years after the EBA capital exercise.

Turning to the estimated differences in the banks' ΔCoVaR and (abs- and rel.) SRISK, we can see from Panels B and C that the increase in regulatory capital in addition to having no short-term effect, also did not have a positive effect on participating banks in the long-run. EBA banks did not have a significantly lower contribution to systemic risk or lower capital shortfall than non-participating banks two and three years, respectively, after the capital exercise.

4.3 Do higher capital requirements reduce systemic risk?

The simple comparisons of the systemic risk estimates of participating and non-participating banks have already highlighted that EBA banks suffered a temporary, yet large increase in their vulnerability to market shocks while their systemic risk contribution did not change. Next, we test the possibility that these results are simply confounded by the fact that our previous analysis lacked further bank-level control variables. We therefore estimate cross-sectional regressions of our systemic risk proxies using our full sample of participating and non-participating banks in Tables III-V.

[Place Table III about here.]

The first column in Table III reports the results of difference-in-differences regressions using the before-after (2012-2010) differences in banks' MES as the dependent variable. We find further empirical evidence for our previous conclusion that participating banks experienced a statistically and economically increase in their exposure to market downturns. More precisely, the MES of EBA banks increased by almost 10% starting from a level of just about 3% in 2010. In the second and third column of Table III, we repeat our analysis but widen the time window around the treatment to test whether the dramatic increase we find in the participating banks' MES is still traceable two and three years after the capital exercise. The results in columns two and three confirm this suspicion as both the statistical and economical significance of the treatment dummy vanish as we move farther away from 2011. Furthermore, we can see from the results in the first column that the changes in MES are not affected in a significant way by the changes in tier 1 capital. Although the EBA capital exercise led to a significant boost in banks' capital ratios, it thus seems that the improved capitalization of participating banks did not have an effect on the market's overall assessment of the banks' systemic risk exposure.

Next, we turn to the corresponding analysis of the sample banks' contribution to systemic fragility as measured by their ΔCoVaR. Results of the respective difference-in-differences regressions are shown in Table IV.

[Place Table IV about here.]

The results of the cross-sectional DiD-regressions provide us with further evidence that the change in capital regulation did not have its intended outcome. For all three time windows, the treatment group of participating banks did not have a significantly lower average contribution to systemic risk compared to banks in the control group. It thus appears as if the increase in banks' regulatory capital ratios did neither have a positive short- nor long-term effect on financial stability.

Finally, we repeat our cross-sectional DiD-regressions of our sample banks' (relative) SRISK estimates. The results of these regressions are presented in Table V.[11]

[Place Table V about here.]

From the results given in Table V, we can see that increasing the regulatory minimum capital ratio of banks has no statistically significant effect on the banks' (relative) SRISK (the same result

[11] The corresponding results on the banks' absolute SRISK estimates show a similar picture and are relegated to Table IA.I in the Internet Appendix.

is obtained in Table IA.I in the Internet Appendix for the absolute SRISK estimates). Moreover, this result holds for all three time horizons after the change in capital regulation. As such, it seems as if the increase in minimum capital requirements did not have its intended effect on financial stability with average capital shortfalls of participating banks behaving in the same manner as those of non-participating banks. This result is particularly surprising as a bank's leverage is a direct input of its SRISK (see Benoit et al., 2013; Engle et al., 2014; Brownlees and Engle, 2017) and the forced increase in capital ratios of EBA banks should have lead to a decrease in capital shortfalls. However, the mechanical decrease in a bank's SRISK / capital shortfall due to the improved capitalization appears to have been offset by the increased exposure of its equity to market shocks. We investigate this finding in more detail below.

To further underline the validity of our main findings, we perform two additional sets of panel regressions of the different systemic risk measures. In these regressions, instead of using the differences in systemic risk as the dependent variable, we regress the levels of the systemic risk estimates in each bank-year on two dummy variables for the post-EBA-period and inclusion in the treatment group as well as various control variables. As a robustness check, we repeat our panel regressions for our complete sample of (unmatched) banks (Panel A) as well as for the sample of matched banks (Panel B) and report the results in Table VI.

[Place Table VI about here.]

The results for the full sample of unmatched banks in Panel A confirm our previous findings that participating banks suffered a statistically and economically significant increase in their idiosyncratic exposure to tail risk in the financial sector. Again, the increase in regulatory capital requirements had no significant impact on the participating banks' capital shortfalls with the interaction term of the Post-EBA-period and the treatment group dummies being statistically insignificant in both the regressions of the absolute and the relative SRISK of banks. In contrast to our cross-sectional regressions, however, the results given in column four of Panel A suggest that the EBA capital exercise had a mildly positive effect on the participating banks' contribution to systemic risk. The interaction term is statistically significant at the 10% level and carries a positive sign meaning that the change in capital requirements led to an average increase in banks' ΔCoVaR estimates and thus a decrease in systemic risk. Turning to the results of our panel regressions in which we only use the sample of matched EBA- and Non-EBA-banks in Panel B, we can see that this finding is not robust and the change in a bank's ΔCoVaR again becomes insignificant. In contrast, our result that the forced increase in capital ratios caused a severe, significant spike in the participating banks' average MES remains valid.

4.4 Which factors drive the regulation-induced changes in systemic risk?

The results of our analysis have so far shown that the 2011 EBA capital exercise led to a significant increase in the participating banks' exposure to market tail risk. At the same time, the change in regulation missed its intended effect of sustainably reducing the banks' active contribution to systemic risk. As a consequence of these somewhat surprising results, we now want to analyze these findings in more detail by disentangling the effect of the regulators' treatment on the different drivers of the banks' MES, SRISK, and ΔCoVaR. For this purpose, we estimate both cross-sectional and panel regressions of the four main factors that drive our systemic risk proxies (see Benoit et al., 2013, for a theoretical analysis of the determinants of MES, ΔCoVaR, and SRISK).[12] The results of these regressions are presented in Tables VII (cross-sectional) and VIII (panel regressions):

[Place Tables VII and VIII about here.]

The results given in Table VII show that neither the volatility (Panel A) of a bank's stock return nor its correlation (Panel D) with the financial sector are significantly impacted by the change in regulation. Panel B shows that the VaR of the participating EBA banks increased slowly relative to non-participating banks from 2011 to 2014. These changes, however, though increasing, are not statistically significant. In contrast, the results given in Panel C show that participating banks experienced a steady increase in their systematic risk as measured by the EBA banks' beta factor.

[12] Formal representations of the systemic risk measures in terms of the underlying return series' volatility, correlation, beta factors, and Value-at-Risk are summarized in Table IA.II in the Internet Appendix.

While the difference between EBA and non-EBA banks was insignificant between 2010 and 2012, the difference was statistically significant at the 10% level for the comparison of 2010 to 2014.

Turning to the results of the panel regressions presented in Table VIII, we can see that the change in capital requirements led to an increase in correlation and systematic risk, while at the same time increased the individual banks' Value-at-Risk. None of these results, however, are robust to shifting from our full sample to our sample of matched banks. In summary, we can conclude that especially the changes in the EBA banks' MES are predominantly driven by a significant increase in the banks' systematic risk that was accompanied to a lesser extent by an increase in the banks' VaR.

4.5 Through which channels does higher capital affect a bank's systemic relevance?

In this part of our analysis, we examine which of the possible channels of the EBA capital exercise on systemic risk appear to be able to explain our empirical findings. To help with our analysis, we calculate the differences-in-differences for several bank characteristics between participating and non-participating banks and report the results in Table IX.

[Place Table IX about here.]

We start by looking at the question through which channels higher regulatory capital requirements could affect a bank's *exposure* to systemic risk. First, our findings are not consistent with either the *Capital Cushion* or the *Safety Channel* as the predicted and the actual effects on the MES go in opposite directions. Next, we can also exclude the *cost channel* as the banks' appear to predominantly adjust their capital by reducing their lending as measured by the total (log) amount of loans (and not via capital injections). This finding is similar to the one reported by Gropp et al. (2016) whose main argument is that the EBA capital exercise led banks to increase their capital ratios by cutting down their lending activities. In this respect, it is interesting to note that while we observe the same pattern in bank lending, we are not able to reproduce the reported average increase in capital ratios. In fact, the DiD in the tier 1 capital ratios of participating and non-participating banks is statistically insignificant both in the short- and long-run. This differing result is most likely due to the minor differences between our sample and the one of Gropp et al. (2016). Yet, the lack of robustness of this central finding casts additional doubt on the efficacy of the EBA exercise in strengthening capital buffers.

Next, our results are not consistent with the predictions of the *Reduced Moral Hazard Channel*. Again, the average increase in the EBA banks' MES contradicts the hypothesis that higher capital requirements reduces bank managers' incentives to take on excessive risks. In addition to this, as evidenced by the results in Table IX, we do not find a significant change in the participating banks' volatility or z-score relative to non-participating banks. As such, it appears as if higher capital requirements did not significantly affect the EBA banks' default risk. Consequently, we rule out that the changes in participating banks' MES are due to a change in managerial incentives for risk-taking. Finally, the *Stigma Channel*, the only remaining one that predicts an increasing effect on a bank's systemic risk exposure appears to dominate all other explanations of the effect of the EBA capital exercise. The DiD-results given in Table IX concerning the participating banks' reduction in lending further support this channel.

Turning to the potential explanations of the effect on a bank's systemic risk *contribution*, we can immediately discard the *stigma* channel as we only find a mildly significant decrease in an EBA bank's contribution to financial fragility as shown in Table VI. The same argument applies for the *Too-Big-To-Fail Channel* which also predicted an increase in systemic risk due to higher capital requirements. Next, our result that the average contribution of EBA banks to systemic risk slightly decreased could also be indicative of the validity of the *Reduced Moral Hazard Channel*. However, as shown by the results on the z-score and return volatility, participating banks did not experience a robust significant decrease in their risk-taking. In contrast, our findings are consistent with the *Safety Channel* and consequently with the *Market Power Channel*. The results on our variable Market Share in Table IX show a clear (and statistically significant) upward trend in the average market power of banks that participated in the EBA capital exercise. As such, our findings seem to confirm the *concentration-stability* view.

4.6 Other robustness checks

We run additional robustness tests to ensure the validity of our findings.[13] First, we re-estimate our measures of systemic risk using the *Datastream EU Bank Index* in order to mitigate the possibility that our findings are driven by a specific choice of the index. We then run our cross-sectional and panel regressions using the respective proxies of systemic risk as our dependent variables (see Panel A of Table IA.III, IA.IV, IA.V and IA.VI in the Internet Appendix). Our result, an increasing effect of the EBA designation on MES in the year following the capital exercise, also holds in this scenario. Again, the other measures are unaffected.

Second, we construct a balanced sample of EBA and non-EBA banks using propensity score matching based on a bank's total assets only. Our baseline matching procedure uses six covariates and thus, compares banks in the treatment and control group by looking at various types of bank characteristics. However, due to possibly missing data items or too many covariates, the matching might suffer from being too restrictive. Thus, as a robustness check, we match banks in the treatment and control group that are similar in size and confirm our findings (see Panel B in Table IA.III - IA.VI). Third, we repeat the analyses of the second robustness check using the alternative bank index and are able to validate our findings (see Panel C in Table IA.III - IA.VI).

5 Conclusion

In this paper, we study the effects of the 2011 EBA capital exercise on the systemic risk of European banks. Using the change in capital regulation as a quasi-natural experiment, we show that the increase in banks' capital requirements did not lead to a significant decrease in the systemic risk of participating banks. While we do find a weak decrease in the average contribution of EBA banks to the systemic risk of the European banking sector, this finding is fallacious at best. First, the

[13]Results are reported in the Internet Appendix.

stabilizing effect of the increase in capital requirements was transitory with the average systemic risk contribution of participating banks decreasing again one year after the exercise. Second, banks that did not participate in the EBA capital exercise continuously decreased their systemic risk contribution as well and surpassed participating banks just two years after the exercise.

At the same time, we find EBA banks to have experienced a dramatic increase in their average exposure to systemic spillover effects from the financial sector. The stocks of banks who had to increase their capital ratio subsequently had a significantly higher risk of losses conditional on the sector going down. Our findings are most consistent with the idea of the change in regulation stigmatizing (perceivably) undercapitalized banks. As such, our findings cast serious doubt on the efficacy of the EBA capital exercise. On the one hand, the change in capital ratios appears to have red-flagged participating banks as undercapitalized and could have forewarned investors of future impediments to the EBA banks' business. On the other hand, the EBA exercise seems to have missed its primary intended target: a sustained decrease in systemic risk.

The main policy implication of our paper is that forced increases in bank capital ratios do not appear to be as efficient in reducing systemic risk as regulators might expect them to be. In addition to the well-documented adverse effects of capital regulation on lending and thus the real economy (see, e.g., Berger and Udell, 1994; Kashyap et al., 2008; Gropp et al., 2016; Jiménez et al., 2017), a forced increase in capital ratios for a subset of banks could even destabilize rather than stabilize the financial sector. In this context, our analysis underlines the risks associated with tougher capital regulation for a selected group of banks rather than enacting sector-wide changes to capital requirements. Similarly, our results highlight the adverse effects of singling out systemically relevant banks as it is also done in the various lists of systemically important financial institutions.

Appendix I: Variable definitions.

The appendix presents definitions for all dependent and independent variables that are used in the empirical study. Stock price data are retrieved from *Datastream* while financial accounting data are from *Bankscope*.

Variable	Description
Dependent variables	
Dynamic MES	Dynamic Marginal Expected Shortfall as defined by Acharya et al. (2017) and calculated following the procedure laid out by Brownlees and Engle (2017).
ΔCoVaR	Conditional ΔCoVaR as defined by Adrian and Brunnermeier (2016), measured as the difference between the Value-at-Risk (VaR) of a country-specific financial sector index conditional on the distress of a particular bank and the VaR of the sector index conditional on the median state of the bank. As state variables for the computation of conditional ΔCoVaR, we employ the change in the Euro yield curve, the change between the ten-year Euro area yield rate and the three-month Euro interest rate, the Euro Stoxx 50 return, real estate returns in excess of the Euro Stoxx 50 equity market, the short-term Treasury Bill Eurodollar spread and the change in the credit spread VSTOXX.
SRISK	Average annual estimate of the Systemic Risk Index as proposed by Acharya et al. (2012) and Brownlees and Engle (2017). The SRISK estimate for bank j at time t is given by $\text{SRISK}_{j,t} = \text{Equity}_{j,t}\left[k \cdot \text{Leverage}_{j,t} + (1-k)\text{LRMES}_{j,t} - 1\right]$ where k is set to 8% to denote the regulatory capital ratio, $\text{Leverage}_{j,t}$ is the bank's book value of debt divided by $\text{Equity}_{j,t}$, the bank's market value of equity, $\text{LRMES}_{j,t}$ is the long run Marginal Expected Shortfall defined as $1 - \exp(-18 \cdot \text{dynMES}_{j,t})$, where $\text{dynMES}_{j,t}$ is the dynamically estimated MES.
NSRISK	SRISK divided by a bank's total assets and multiplied by 1,000.
Beta	Systematic risk as measured by a bank's beta factor.
$\text{VaR}_{5\%}$	A bank's Value-at-Risk with confidence level 95%, defined by $Pr(r_{i,t} < -VaR_{5\%}) = 5\%$.
Volatility	Standard deviation of a bank's daily stock returns within a year.
Independent variables	
Total assets	Natural logarithm of a bank's total assets at fiscal year end.
Deposit ratio	Total deposits divided by total assets.
Loan loss provisions / liabilities	Ratio of expenses set aside as an allowance for uncollectable or troubled loans divided by total liabilities.
Net interest margin	Net interest income divided by total assets.
Tier 1 Capital	A bank's core Tier 1 capital over a bank's risk-weighted assets.
Loan ratio	Total loans divided by total assets.
Loans	Natural logarithm of a bank's total loans at fiscal year end.
ROA	Return on Assets defined as net income over total assets.
Loan ratio	Total loans divided by total assets.
EBA	Dummy variable that takes on the value of one if the bank is an "EBA bank", i.e., it participated in the capital exercise in 2011, and zero otherwise.
Market Share	Share of total liabilities in the country a bank is located in.
Z-score	The Z-score is defined as $z_{k,t} = \frac{\text{ROA}_{k,t} + \text{CAR}_{k,t}}{\sigma_{k,t}}$ where $\text{ROA}_{k,t}$ is a bank's return on assets at time *t*, $\text{CAR}_{k,t}$ is the capital-to-assets ratio, and $\sigma_{k,t}$ is the standard deviation of a bank's ROA.

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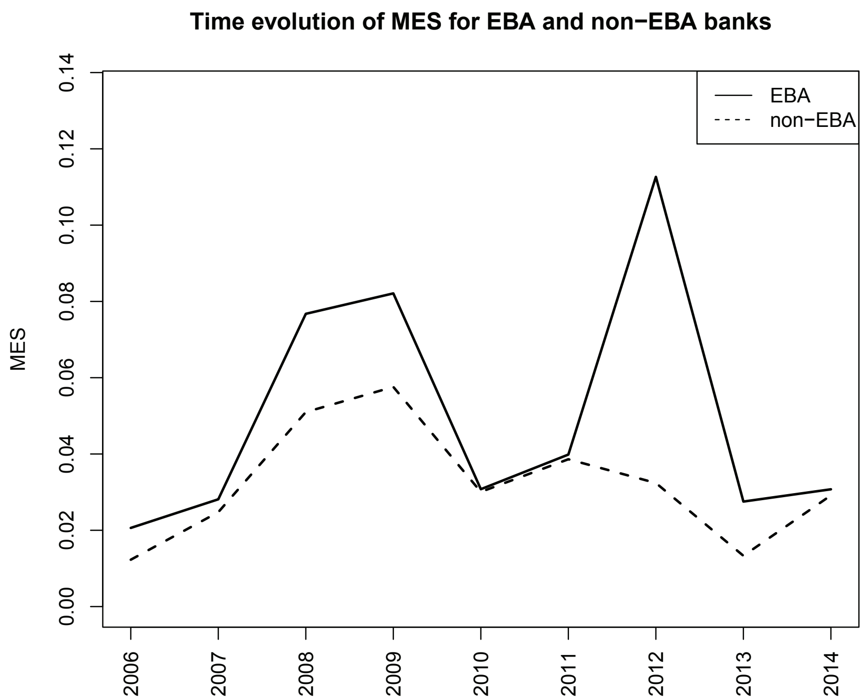
Figure 1: Time evolution of systemic risk measures for EBA and non-EBA banks

These figures show the time evolution of MES and ΔCoVaR for EBA and non-EBA banks, respectively, from 2006-2014. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock price and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I.



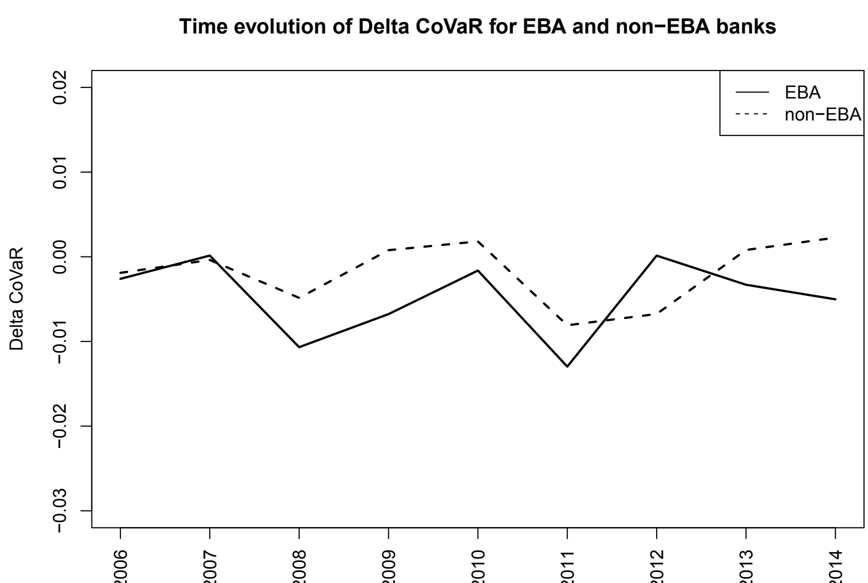


Table I: Summary statistics

This table provides summary statistics for a panel of European banks from 2006 to 2014 (Panel A) and a cross-section in 2010 (Panel B). We report the number of observations, the mean, minimum, and maximum value, as well as standard deviations. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I.

Panel A: 2006-2014	N	Mean	sd	Min	Max
ΔCoVaR	1,787	-0.002	0.016	-0.152	0.076
(Dynamic) MES	1,787	0.025	0.042	-0.147	0.553
SRISK (in EUR bn)	1,291	9.355	22.033	0.002	142.240
NSRISK	1,291	0.055	0.000	0.041	0.055
EBA	3,285	0.151	0.358	0.000	1.000
Deposit ratio	2,167	0.134	0.153	0.000	1.074
Loan loss provisions / liabilities	2,084	4.637	5.634	-0.110	85.506
Net interest margin (in %)	2,271	3.129	3.014	-10.203	50.877
Tier 1 Capital	1,512	13.100	5.657	-6.100	74.300
Total assets (in EUR bn)	2,272	109.676	322.070	0.013	2586.701
Loan ratio	2,250	0.620	0.188	0.000	0.992
ROA	2,271	0.005	0.027	-0.907	0.184

Panel B: 2010	N	Mean	sd	Min	Max
ΔCoVaR	215	-0.001	0.023	-0.152	0.052
(Dynamic) MES	215	0.018	0.023	-0.089	0.087
SRISK (in EUR bn)	148	9.674	22.273	0.002	109.876
NSRISK	148	0.055	0.000	0.054	0.055
EBA	365	0.151	0.358	0.000	1.000
Deposit ratio	241	0.132	0.152	0.000	0.750
Loan loss provisions / liabilities	230	4.447	4.830	-0.095	48.165
Net interest margin (in %)	250	3.004	3.049	-10.203	38.822
Tier 1 Capital	180	13.795	6.720	4.300	74.300
Total assets (in EUR bn)	250	115.761	329.401	0.031	1998.158
Loan ratio	248	0.629	0.186	0.001	0.916
ROA	250	0.004	0.017	-0.137	0.064

Table II: Summary Statistics before and after EBA

This table shows results of (two-sided) t-tests on differences-in-differences for different systemic risk measures, i.e., the dynamic MES (MES), ΔCoVaR, SRISK, and NSRISK between EBA banks' and their matching non-EBA banks' in 2010 and its values in 2012 (Panel A), 2013 (Panel B), or 2014 (Panel C), respectively. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock price and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate an estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively.

		MES		ΔCoVaR	SRISK		NSRISK	
Panel A: 2010 and 2012	No of observations: 35							
	EBA Banks: after minus before	0.0914	***	-0.0004	0.6625		-0.0002	
		[0.000]		[0.921]	[0.270]		[0.983]	
	Control group: after minus before	0.0262	***	-0.0002	-0.0060		0.0082	*
		[0.002]		[0.967]	[0.989]		[0.067]	
	DiD: EBA vs. Control Group	0.0652	***	-0.0003	0.6685		-0.0084	
		[0.004]		[0.962]	[0.379]		[0.344]	
Panel B: 2010 and 2013	No of observations: 37							
	EBA Banks: after minus before	-0.0030		-0.0038	-1.9986	*	0.0268	*
		[0.416]		[0.248]	[0.050]		[0.061]	
	Control group: after minus before	-0.0139	***	0.0003	-0.5944		0.0338	***
		[0.000]		[0.885]	[0.317]		[0.000]	
	DiD: EBA vs. Control Group	0.0109	**	-0.0042	-1.4042		-0.0070	
		[0.041]		[0.273]	[0.214]		[0.663]	
Panel C: 2010 and 2014	No of observations: 37							
	EBA Banks: after minus before	0.0019		-0.0046	0.0613		0.0293	
		[0.587]		[0.182]	[0.950]		[0.168]	
	Control group: after minus before	-0.0033		0.0013	-0.0203		0.0230	***
		[0.182]		[0.736]	[0.972]		[0.000]	
	DiD: EBA vs. Control Group	0.0052		-0.0060	0.0816		0.0063	
		[0.234]		[0.233]	[0.941]		[0.775]	

Table III: EBA designations and Marginal Expected Shortfall: Cross-sectional Regressions

This table shows results from cross-sectional regressions of the difference between EBA banks' and their matching non-EBA banks' Marginal Expected Shortfall (MES) in 2010 and its values in 2012, 2013, or 2014, respectively, on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors.

	[1]	[2]	[3]
Dependent variable:	ΔMES [2012-2010]	ΔMES [2013-2010]	ΔMES [2014-2010]
EBA	**0.0943****	0.0084	-0.0092
	[0.022]	[0.376]	[0.182]
Tier 1 capital	-0.0037	0.0035	0.0034
	[0.591]	[0.225]	[0.280]
Deposit ratio	-0.0329	-0.0555	0.0346
	[0.797]	[0.341]	[0.274]
Loan loss provision / liabilities	0.0173	0.0017	0.0033
	[0.197]	[0.313]	[0.353]
Net interest margin (in %)	-0.0001	-0.0084	-0.0043
	[0.996]	[0.304]	[0.633]
Loan ratio	-0.1560	0.0255	-0.0096
	[0.372]	[0.453]	[0.680]
ROA	-1.0910	0.6140	-0.2850
	[0.339]	[0.244]	[0.461]
Constant	0.0472	-0.0267	-0.0308
	[0.714]	[0.489]	[0.531]
Country FE	YES	YES	YES
N	78	79	80
Adjusted R^2	0.476	0.305	0.465

Table IV: EBA designations and ΔCoVaR (EU): Cross-sectional Regressions

This table shows results from cross-sectional regressions of the difference between EBA banks' and their matching non-EBA banks' ΔCoVaR in 2010 and its values in 2012, 2013, or 2014, respectively, on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors.

	[1]	[2]	[3]
Dependent variable:	Δ(ΔCoVaR) [2012-2010]	Δ(ΔCoVaR) [2013-2010]	Δ(ΔCoVaR) [2014-2010]
EBA	0.0120	0.0001	0.0026
	[0.117]	[0.988]	[0.850]
Tier 1 capital	0.0005	0.0036	0.0008
	[0.881]	[0.138]	[0.762]
Deposit ratio	**-0.0722****	**-0.0667***	**-0.0817*****
	[0.031]	**[0.083]**	**[0.001]**
Loan loss provision / liabilities	-0.0051	-0.0021	-0.0059
	[0.321]	[0.476]	[0.177]
Net interest margin (in %)	0.0055	0.0072	0.0102*
	[0.499]	[0.377]	[0.097]
Loan ratio	-0.0303	0.0152	-0.0002
	[0.446]	[0.625]	[0.997]
ROA	**-1.9330*****	**-0.9830****	**-0.8160****
	[0.000]	**[0.019]**	**[0.047]**
Constant	0.0333	-0.0445	0.0176
	[0.591]	[0.225]	[0.688]
Country FE	YES	YES	YES
N	78	79	80
Adjusted R^2	0.501	0.411	0.358

Table V: EBA designations and NSRISK: Cross-sectional Regressions

This table shows results from cross-sectional regressions of the difference between EBA banks' and their matching non-EBA banks' NSRISK (SRISK divided by a bank's total assets and multiplied by 1,000) in 2010 and its values in 2012, 2013, or 2014, respectively, on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors.

	[1]	[2]	[3]
Dependent variable:	ΔNSRISK [2012-2010]	ΔNSRISK [2013-2010]	ΔNSRISK [2014-2010]
EBA	0.0032	0.0046	-0.0021
	[0.739]	[0.298]	[0.704]
Tier 1 capital	-0.0068	-0.0022	-0.0032
	[0.126]	[0.601]	[0.335]
Deposit ratio	0.0463	-0.0622	-0.0255
	[0.254]	[0.335]	[0.712]
Loan loss provision / liabilities	**-0.0062***	**-0.0056**	**-0.0049***
	[0.003]	**[0.016]**	**[0.054]**
Net interest margin (in %)	0.0064	-0.0072	0.0032
	[0.277]	[0.435]	[0.715]
Loan ratio	**-0.0920***	-0.0293	**-0.0654**
	[0.079]	[0.341]	**[0.042]**
ROA	**-0.6620**	**0.7460***	0.0476
	[0.043]	**[0.056]**	[0.900]
Constant	**0.1450***	0.0932	0.0876
	[0.078]	[0.192]	[0.156]
Country FE	YES	YES	YES
N	74	76	77
Adjusted R^2	0.823	0.940	0.972

Table VI: EBA Designations and Systemic Risk: Panel Regressions

This table shows results from panel regressions of EBA banks' and their matching non-EBA banks' systemic risk from 2006 to 2014 on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise and its interaction term with a dummy variable that is one in 2011-2014 and zero before 2011. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors. Panel A reports results using all banks from the initial data sample and Panel B includes only designated banks and banks from a control group that were matched to treated banks at least once.

Panel A: All banks	[1]	[2]	[3]	[4]
Dependent variable:	MES	SRISK	NSRISK	ΔCoVaR
EBA $\times$ Post-EBA	**0.0176****	-0.7860	-0.0001	**0.0030***
	[0.018]	[0.754]	[0.262]	**[0.063]**
EBA	**0.0158*****	**14.2000*****	0.00002	**-0.0027***
	[0.000]	**[0.000]**	[0.282]	**[0.086]**
N	1,083	920	920	1,083
Adjusted R^2	0.321	0.666	0.009	0.065

Panel B: Matched banks	[1]	[2]	[3]	[4]
Dependent variable:	MES	SRISK	NSRISK	ΔCoVaR
EBA $\times$ Post-EBA	**0.0171****	-3.3610	-0.00001	0.0022
	[0.049]	[0.282]	[0.127]	[0.514]
EBA	**0.0193*****	**6.5040****	0.000002	-0.00317
	[0.002]	**[0.012]**	[0.682]	[0.109]
N	474	440	440	474
Adjusted R^2	0.324	0.765	0.414	0.055
Control variables	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

Table VII: EBA designations and systemic risk components: cross-sectional regressions

This table shows results from cross-sectional regressions of the difference between EBA banks' and their matching non-EBA banks' systemic risk components in 2010 and its values in 2012, 2013, or 2014, respectively, on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise. Input factors of systemic risk measures are shown in Table IA.II. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors.

Panel A: Volatility	[1]	[2]	[3]
Dependent variable:	Volatility [2012-2010]	Volatility [2013-2010]	Volatility [2014-2010]
EBA	-0.027	-0.167	-0.092
	[0.485]	[0.368]	[0.159]
N	78	79	80
Adjusted R^2	0.791	0.470	0.498
Panel B: VaR	[1]	[2]	[3]
Dependent variable:	VaR [2012-2010]	VaR [2013-2010]	VaR [2014-2010]
EBA	0.002	0.013	0.015
	[0.669]	[0.439]	[0.237]
N	78	79	80
Adjusted R^2	0.815	0.401	0.408
Panel C: Beta	[1]	[2]	[3]
Dependent variable:	Beta [2012-2010]	Beta [2013-2010]	Beta [2014-2010]
EBA	0.080	0.126	**0.158***
	[0.243]	[0.152]	**[0.078]**
N	78	79	80
Adjusted R^2	0.444	0.427	0.419
Panel D: Correlation	[1]	[2]	[3]
Dependent variable:	Correlation [2012-2010]	Correlation [2013-2010]	Correlation [2014-2010]
EBA	0.032	0.079	-0.105
	[0.572]	[0.270]	[0.402]
N	78	79	80
Adjusted R^2	0.439	0.384	0.702
Control Variables	YES	YES	YES
Country clustered se	YES	YES	YES

Table VIII: EBA designations and systemic risk components: panel regressions

This table shows results from panel regressions of EBA banks' and their matching non-EBA banks' systemic risk components from 2006 to 2014 on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise and its interaction term with a dummy variable that is one in 2011-2014 and zero before 2011. Input factors of systemic risk measures are shown in Table IA.II. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors. Panel A reports results using all banks from the initial data sample and Panel B includes only designated banks and banks from a control group that were matched to treated banks at least once.

Panel A: All banks	[1]	[2]	[3]	[4]
Dependent variable:	Volatility	Correlation	VaR	Beta
EBA × Post-EBA	-0.034	**-0.134*** **	**0.004***	**-0.061*** **
	[0.171]	**[0.000]**	**[0.072]**	**[0.027]**
EBA	0.009	**0.185*** **	-0.002	**0.128*** **
	[0.610]	**[0.000]**	[0.228]	**[0.000]**
N	1,083	1,083	1,083	1,083
Adjusted R^2	0.472	0.671	0.483	0.266
Panel B: Matched banks	[1]	[2]	[3]	[4]
Dependent variable:	Volatility	Correlation	VaR	Beta
EBA × Post-EBA	-0.0712	0.0029	0.0064	0.0073
	[0.295]	[0.942]	[0.308]	[0.837]
EBA	**0.0625*** **	**0.0700*** **	**-0.0068*** **	-0.0079
	[0.011]	**[0.008]**	**[0.005]**	[0.773]
N	474	474	474	474
Adjusted R^2	0.487	0.674	0.512	0.521
Control variables	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

Table IX: Channels of the EBA capital exercise

This table shows results of (two-sided) t-tests on differences-in-differences for several bank characteristics between EBA banks' and their matching non-EBA banks' in 2010 and its values in 2012 (Panel A), 2013 (Panel B), or 2014 (Panel C), respectively. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. Accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate an estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively.

		Loans	Tier 1 Capital	Market Share	Z-score	Volatility
Panel A: 2010 and 2012	No of observations:	43	36	41	42	37
	EBA Banks: after minus before	-0.0316	1.6422 ***	0.0014	-4.4860	0.0680 **
		[0.112]	[0.000]	[0.523]	[0.152]	[0.023]
	Control group: after minus before	0.0341	1.3933 ***	-0.0022	-7.8497	0.0688 **
		[0.211]	[0.002]	[0.116]	[0.165]	[0.017]
	DiD: EBA vs. Control Group	-0.0657 **	0.2489	0.0037	3.3637	-0.0008
		[0.041]	[0.678]	[0.119]	[0.516]	[0.984]
Panel B: 2010 and 2013	No of observations:	43	31	41	42	39
	EBA Banks: after minus before	-0.0686 ***	2.1084 ***	-0.0003	9.1605	-0.0278
		[0.005]	[0.000]	[0.921]	[0.101]	[0.356]
	Control group: after minus before	0.0210	2.0661 ***	-0.0074 **	-5.9942	0.0609
		[0.548]	[0.000]	[0.034]	[0.411]	[0.411]
	DiD: EBA vs. Control Group	-0.0896 **	0.0423	0.0072 *	15.1546 *	-0.0887
		[0.030]	[0.956]	[0.073]	[0.093]	[0.290]
Panel C: 2010 and 2014	No of observations:	43	30	41	42	39
	EBA Banks: after minus before	-0.0708 **	2.9573 ***	0.0124 ***	13.5387 **	-0.0607 **
		[0.010]	[0.000]	[0.001]	[0.027]	[0.020]
	Control group: after minus before	0.0391	3.2537 ***	0.0004	3.0132	-0.0142
		[0.375]	[0.000]	[0.901]	[0.723]	[0.631]
	DiD: EBA vs. Control Group	-0.1099 **	-0.2963	0.0120 ***	10.5254	-0.0465
		[0.035]	[0.690]	[0.008]	[0.306]	[0.285]

Internet Appendix to
"Do Higher Bank Capital Requirements Really Decrease Systemic Risk?"

This Internet Appendix contains the results and tables of several additional analyses of our main research question as well as of further robustness checks.

Table IA.I: EBA designations and SRISK: Cross-sectional Regressions

This table shows results from cross-sectional regressions of the difference between EBA banks' and their matching non-EBA banks' SRISK in 2010 and its values in 2012, 2013, or 2014, respectively, on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors.

	[1]	[2]	[3]
Dependent variable:	ΔSRISK [2012-2010]	ΔSRISK [2013-2010]	ΔSRISK [2014-2010]
EBA	0.8030	2.2630	3.3900
	[0.356]	[0.171]	[0.133]
Tier 1 capital	-0.3710	**-1.4310****	**-1.3800***
	[0.366]	**[0.043]**	**[0.073]**
Deposit ratio	-6.9430	0.0798	-3.9530
	[0.174]	[0.988]	[0.466]
Loan loss provision / liabilities	-0.9250	-1.0900	-1.3850
	[0.199]	[0.181]	[0.145]
Net interest margin (in %)	1.8690	2.4230	2.9970
	[0.164]	[0.222]	[0.157]
Loan ratio	**-10.6100***	4.6400	-5.0920
	[0.070]	[0.460]	[0.450]
ROA	**-14.9400**	80.1800	124.5000
	[0.810]	[0.438]	[0.299]
Constant	9.6340	6.7210	10.7100
	[0.130]	[0.251]	[0.139]
Country FE	YES	YES	YES
N	74	76	77
Adjusted R^2	0.327	0.385	0.320

Table IA.II: Comparison of systemic risk measure.

This table summarizes the definitions and input factors of the systemic risk measures we use in our main analysis. The representations of the different systemic risk measures are taken from Benoit et al. (2013) and Brownlees and Engle (2017).

Systemic risk measure	Representation
MES	$\rho_{j,t}\sigma_{j,t}/\sigma_{M,t} \cdot \mathbb{E}\left(R_{M,t} \,\middle|\, R_{M,t} < VaR_{M,t}(\alpha)\right)$
ΔCoVaR	$\rho_{j,t}\sigma_{M,t}/\sigma_{j,t}\left[VaR_{j,t}(\alpha) - VaR_{M,t}(0.5)\right]$
SRISK	$Equity_{j,t}\left[k \cdot Leverage_{j,t} + (1-k)LRMES_{j,t} - 1\right]$

Table IA.III: EBA designations and Marginal Expected Shortfall: Cross-sectional Regressions (robustness)

This table shows results from cross-sectional regressions of the difference between EBA banks' and their matching non-EBA banks' Marginal Expected Shortfall (MES) in 2010 and its values in 2012, 2013, or 2014, respectively, on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise. Panel A shows panel regressions where the systemic risk measures are calculated using the *Datastream EU Bank Index*. Panel B shows results of regressions that employ a balanced sample of matched banks based on a bank's total assets only; Panel C shows results from the same sample but using the alternative bank index in the calculation of systemic risk measures. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors and country-fixed effects.

Panel A: Alternative Bank Index	[1]	[2]	[3]	[4]
	ΔMES 2012	ΔMES 2013	ΔMES 2014	ΔMES 2015
EBA	**0.1020***	0.0011	-0.0124	-0.0191
	[0.067]	[0.922]	[0.204]	[0.498]
N	53	54	55	50
Adjusted R^2	0.350	0.062	0.272	-0.065

Panel B: Matching by size	[1]	[2]	[3]	[4]
	ΔMES 2012	ΔMES 2013	ΔMES 2014	ΔMES 2015
EBA	**0.0755****	0.0051	-0.0067	-0.0283
	[0.029]	[0.593]	[0.228]	[0.475]
N	72	74	75	71
Adjusted R^2	0.513	0.166	0.344	0.239

Panel C: Matching by size / Alternative Bank Index	[1]	[2]	[3]	[4]
	ΔMES 2012	ΔMES 2013	ΔMES 2014	ΔMES 2015
EBA	**0.0619****	0.0056	**-0.0095***	-0.0339
	[0.047]	[0.402]	**[0.079]**	[0.357]
N	72	74	75	71
Adjusted R^2	0.500	0.265	0.367	0.248

Table IA.IV: EBA designations and ΔCoVaR (EU): Cross-sectional Regressions (robustness)

This table shows results from cross-sectional regressions of the difference between EBA banks' and their matching non-EBA banks' ΔCoVaR in 2010 and its values in 2012, 2013, or 2014, respectively, on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise. Panel A shows panel regressions where the systemic risk measures are calculated using the *Datastream EU Bank Index*. Panel B shows results of regressions that employ a balanced sample of matched banks based on a bank's total assets only; Panel C shows results from the same sample but using the alternative bank index in the calculation of systemic risk measures. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors and country-fixed effects.

Panel A: Alternative Bank Index	[1]	[2]	[3]	[4]
	Δ(ΔCoVaR) 2012	Δ(ΔCoVaR) 2013	Δ(ΔCoVaR) 2014	Δ(ΔCoVaR) 2015
EBA	0.0031	-0.0163	0.0045	0.0049
	[0.700]	[0.144]	[0.640]	[0.639]
N	53	54	55	50
Adjusted R^2	0.368	0.449	0.011	-0.030

Panel B: Matching by size	[1]	[2]	[3]	[4]
	Δ(ΔCoVaR) 2012	Δ(ΔCoVaR) 2013	Δ(ΔCoVaR) 2014	Δ(ΔCoVaR) 2015
EBA	0.0132	0.0053	0.0053	0.0139
	[0.163]	[0.477]	[0.673]	[0.390]
N	72	74	75	71
Adjusted R^2	0.693	0.632	0.382	0.531

Panel C: Matching by size / Alternative Bank Index	[1]	[2]	[3]	[4]
	Δ(ΔCoVaR) 2012	Δ(ΔCoVaR) 2013	Δ(ΔCoVaR) 2014	Δ(ΔCoVaR) 2015
EBA	-0.0068	-0.0041	-0.0053	-0.0014
	[0.299]	[0.595]	[0.418]	[0.853]
N	72	74	75	71
Adjusted R^2	0.346	0.511	0.127	0.259

Table IA.V: EBA designations and SRISK: Cross-sectional Regressions (robustness)

This table shows results from cross-sectional regressions of the difference between EBA banks' and their matching non-EBA banks' SRISK in 2010 and its values in 2012, 2013, or 2014, respectively, on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise. Panel A shows panel regressions where the systemic risk measures are calculated using the *Datastream EU Bank Index*. Panel B shows results of regressions that employ a balanced sample of matched banks based on a bank's total assets only; Panel C shows results from the same sample but using the alternative bank index in the calculation of systemic risk measures. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors and country-fixed effects.

Panel A: Alternative Bank Index	[1]	[2]	[3]
	ΔSRISK 2012	ΔSRISK 2013	ΔSRISK 2014
EBA	1.2960	3.0380	3.8820
	[0.213]	[0.219]	[0.118]
N	49	51	52
Adjusted R^2	0.104	0.196	0.190

Panel B: Matching by size	[1]	[2]	[3]
	ΔSRISK 2012	ΔSRISK 2013	ΔSRISK 2014
EBA	0.5660	-1.0400	0.4140
	[0.464]	[0.626]	[0.791]
N	69	71	72
Adjusted R^2	0.420	0.277	0.380

Panel C: Matching by size / Alternative Bank Index	[1]	[2]	[3]
	ΔSRISK 2012	ΔSRISK 2013	ΔSRISK 2014
EBA	0.5660	-1.0380	0.4130
	[0.464]	[0.626]	[0.792]
N	69	71	72
Adjusted R^2	0.420	0.277	0.380

Table IA.VI: EBA Designations and Systemic Risk: Panel Regressions (robustness)

This table shows results from panel regressions of EBA banks' and their matching non-EBA banks' systemic risk from 2006 to 2014 on a dummy variable that is one if a bank was designated as systemically relevant in 2011 by the selection criteria of the European Banking Authority (EBA) and zero otherwise and its interaction term with a dummy variable that is one in 2011-2014 and zero before 2011. Panel A shows panel regressions where the systemic risk measures are calculated using the *Datastream EU Bank Index*. Panel B shows results of regressions that employ a balanced sample of matched banks based on a bank's total assets only; Panel C shows results from the same sample but using the alternative bank index in the calculation of systemic risk measures. The sample is constructed from all listed European banks in *Thomson Reuters Financial Datastream* from which we retrieve stock price data that we complement with financial statement data taken from the *Bankscope* database. All stock market and accounting data are collected in Euro. Variable definitions and data sources are given in Appendix I. P-values are given in parentheses and ***, **, * indicate a coefficient estimate that is statistically significantly different from zero at the 1%, 5%, and 10% level, respectively. All regressions are performed using robust standard errors.

Panel A: Alternative Bank Index	[1]	[2]	[3]	[4]
	MES	SRISK	NSRISK	ΔCoVaR
EBA $\times$ Post-EBA	**0.0234***	-4.0580	**-0.00002***	0.0018
	[0.031]	[0.205]	**[0.073]**	[0.646]
EBA	**0.0190*****	**6.3270*****	0.0029 x 10 $\hat{3}$	-0.0006
	[0.001]	**[0.007]**	[0.635]	[0.786]
N	474	440	440	474
Adjusted R^2	0.297	0.765	0.414	0.037
Panel B: Matching by Size	[1]	[2]	[3]	[4]
	MES	SRISK	NSRISK	ΔCoVaR
EBA $\times$ Post-EBA	**0.0149***	-4.7220	-0.0001	**0.0043***
	[0.023]	[0.113]	[0.295]	**[0.084]**
EBA	**0.0114***	**20.5600*****	0.0001	**-0.0045***
	[0.026]	**[0.000]**	[0.297]	**[0.022]**
N	640	597	597	640
Adjusted R^2	0.365	0.700	0.020	0.063
Panel C: Matching by Size / Alternative Index	[1]	[2]	[3]	[4]
	MES	SRISK	NSRISK	ΔCoVaR
TA matching				
EBA $\times$ Post-EBA	**0.0131***	-4.7220	-0.0001	-0.0006
	[0.042]	[0.113]	[0.295]	[0.836]
EBA	**0.0120***	**20.5600*****	0.0001	0.0017
	[0.016]	**[0.000]**	[0.294]	[0.462]
N	640	597	597	640
Adjusted R^2	0.349	0.700	0.017	0.064
Control variables	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

References

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