

Bank Recapitalizations and Lending: A Little Is Not Enough

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Abstract

This paper analyzes the effect of bank recapitalizations on lending, funding and asset quality of European banks between 2000 and 2013. Controlling for market implied capital shortfall of banks, we find that banks that receive a sufficiently large recapitalization increase lending, raise additional funding and clean up their balance sheets. In contrast, banks that receive a small recapitalization relative to their capital shortfall reduce lending, shrink assets and suffer a drop in deposits and interbank borrowing. These results suggest recapitalizations need to be large enough to lead to new lending.

Key words: Bank recapitalization, lending, zombie banks, bank restructuring, banking crisis

JEL codes: G21, G28

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Government recapitalizations of distressed banks are highly unpopular with the general public. The main reasons are the fiscal burden they impose on the taxpayers, the moral hazard with respect to future crises and the perception that they create rents for bankers. On the other side of the trade-off, particularly relevant during systemic banking crises when a large part of the banking sector is undercapitalized, are the costs of regulatory forbearance. When distressed banks are not recapitalized, they are likely to lend less or engage in zombie lending, which leads to depressed growth (Caballero, Hoshi, and Kashyap 2008; Peek and Rosengren 2005). The fiscal costs of intervention and the output losses resulting from a weak banking sector raise questions about how effective government equity injections really are. Do they increase bank lending? How do they affect bank funding and loan restructuring? Is the lending induced by recapitalizations directed toward efficient projects? How large recapitalizations should be?

Theory suggests banks should be recapitalized when preserving bank-borrower relationships is valuable (Diamond 2001). The level of bank capital is critical both for the bargaining between the bank and investors, and the negotiations of the bank with borrowers (Diamond and Rajan 2000). Undercapitalized banks are subject to the debt overhang problem (Myers 1977). They may forgo profitable new lending as the benefits would mostly accrue to the creditors. An efficient recapitalization program should be designed in way to reduce the debt overhang problem, while limiting the rents it creates for the banks (Philippon and Schnabl 2013). Furthermore, undercapitalized banks may underreport the extent of nonperforming loans to avoid closure or overstate them to receive a larger bailout (Aghion, Bolton, and Fries 1999). The former leads to evergreening of loans to nonviable borrowers. The latter results in excessive liquidation. An optimal recapitalization problem should take into account both inefficiencies.

Empirical literature has focused on two main questions about recapitalizations, whether recapitalizations increase loan supply and whether they increase or reduce bank risk taking. Li (2013) investigates the effect of equity injections under the Troubled Asset Relief Program (TARP) and finds that they increase loan supply. Conversely, Duchin and Sosyura (2014) who look at

mortgage loan applications, find that after receiving TARP funds banks originated riskier loans, but there seems to be no effect on the amount of lending. Giannetti and Simonov (2013) provide insight into both issues by analyzing recapitalizations of Japanese banks. They find that properly recapitalized banks increased lending to creditworthy borrowers, whereas those that received a too small recapitalization, such that they were still in breach of regulatory capital requirements after being recapitalized, only extended more loans to zombie firms. We contribute to this literature by documenting the effect of recapitalizations on multiple aspects of bank behavior, more specifically lending, investing into government securities, adjustment of risk weighted assets, access to different types of funding, loan loss provisioning and recognition of impaired loans.

We analyze recapitalizations of publicly traded European banks in the period from 2000 to 2013. The main identification concern in estimating the effect of intervention is that recapitalized banks are typically experiencing substantial distress before they are intervened. Comparing the distressed recapitalized banks with healthy non-recapitalized ones without properly controlling for the differences between them would lead to biased results. Several papers use political and regulatory connections of banks to instrument the probability of receiving a bailout (Li 2013; Duchin and Sosyura 2014; Berger et al. 2014). We control for bank distress directly by using the market implied capital shortfall as a measure of undercapitalization or distress of banks. This way we can compare banks that are recapitalized with those that are similarly undercapitalized but not (yet) intervened or receive a different recapitalization amount.

We find that a year after being recapitalized, banks increase lending, attract more deposits and make more loan loss provisions. The effects are increasing in the size of recapitalization, relative to total assets of bank. These positive effects, however, do not apply to banks that receive a small recapitalization relative to their capital shortfall. Following such a recapitalization, banks suffer a drop in deposits and interbank funding. Consequently, they cut back on lending. Similarly, banks with a low Tier 1 ratio after recapitalization, which implies the recapitalization was too small to bring them up to a higher capital ratio, shrink risk weighted assets and increase lending

significantly less than banks with a high Tier 1 ratio after recapitalization. Overall, these results suggest that sufficient recapitalizations lead to a substantial increase in lending, whereas banks that get a small recapitalization relative to their shortfall carry out adjustment through reduction of lending and shrinking of risk weighted assets.

The paper is organized as follows. Section 1 reviews the related literature. Section 2 presents the empirical methodology. Section 3 describes the data. Section 4 discusses the results. Robustness checks are in Section 5. Section 6 concludes.

1 Review of related literature

To answer the question whether bank recapitalizations are beneficial, empirical literature has investigated the effects of recapitalizations on bank lending and risk taking. From the effects on loan supply and measures of risk, some inferences can be made about whether recapitalizations lead to efficient allocation of resources. Recent papers studying the effect of government equity injections mostly focus on the Capital Purchase Program (CPP) implemented under the TARP program in the US in the second half of 2008 and 2009. Li (2013) finds that injections of preferred stock with warrants increased loan supply of recapitalized banks. He instruments the indicator for participation at CPP with political connectedness of banks. Those better connected, measured by political contributions of local financial industry to congressmen and by whether the bank has representatives in regulatory bodies, are more likely to receive a bailout. With a similar approach, Duchin and Sosyura (2014) analyze loan mortgage applications and find that banks with TARP funds approved more risky loans, i.e. loans with significantly lower loan to income ratios, the key criterion for the risk of mortgages. But they do not find that recapitalized banks increased loan approvals in general. Interestingly, Black and Hazelwood (2012) find that following the TARP injections the average risk of commercial and industrial loans originated by large banks increased, while small banks originated loans with significantly lower risk, compared to banks that did not receive capital support. Berger and Roman (2013) show that banks that received TARP injections

gained a competitive advantage in terms of both market share and market power; the effects are particularly strong for banks that repaid the injections early. Conclusions about whether origination of loans with higher risk is valuable from the social perspective cannot be easily drawn. Higher risk or an increase in risk-weighted assets may mean banks are extending loans to small and medium enterprises with good projects instead of buying government securities with low risk weights or that they are taking on excessive risks as a consequence of moral hazard.

The paper that is able to most directly distinguish between efficient and wasteful lending is Giannetti and Simonov (2013). They analyze equity injections into Japanese banks between 1998 and 2005. In the first round of recapitalizations all banks received similar injections to avoid signaling, which produced variation across banks; some were still in breach of capital requirements after the intervention. The banks that were sufficiently recapitalized increased lending to creditworthy borrowers with whom they had closer relationships and reduced the exposure to insolvent borrowers. Those that were still undercapitalized after the injection, however, reacted to recapitalizations in the opposite way: they did not increase lending in general but only extended more loans to zombie firms. This is consistent with our results, which show that bank recapitalizations only increase lending if they are large enough, relative to the capital shortfall before recapitalization. Unlike Giannetti and Simonov (2013), we cannot provide direct evidence that the increase in lending resulting from recapitalizations is aimed at productive projects. However, considered together with the results that banks receiving larger recapitalizations also improve their access to market funding and clean up their balance sheets, our findings suggest that new lending is not directed at value-destroying projects.

Another way to answer the question, whether recapitalizations are beneficial is to look at the effect of bank capital over a longer time horizon. Berger and Bouwman (2013) show that capital increases bank survival probabilities and helps them gain market share. For small banks this holds for normal as well as crisis times, while for large banks the effect is only present during banking crises. Consistent with their evidence, we find that better capitalized banks, in our setup those with

lower market implied capital shortfall, have higher loan growth. Moreover, Jimenez et al. (2013) find that capital buffer from accumulated loan loss provisions helped Spanish banks sustain lending during the crisis. Borrowers of banks with a larger buffer were able to borrow more than borrowers of banks with a lower capital buffer. They also show that borrowers of lowly capitalized banks were hardly able to switch to other banks. Similarly, Chodorow-Reich (2014) documents switching problems and shows that firms whose lead bank was more affected by the Lehman collapse reduced employment more than firms whose lead bank from the pre-crisis period was less affected. This evidence provides an argument for bank recapitalizations to preserve bank-borrower relationship.

2 Empirical methodology

We analyze the effect of bank recapitalizations on lending, bank funding sources and asset quality. Recapitalizations, typically in the form of an equity injection by the government or a conversion of claims to private creditors, are done when banks are distressed, which poses an identification problem as distressed banks are different from those that are not distressed. Ideally, one would compare a group of recapitalized banks with a group of banks that are similarly distressed but for some random reason not (yet) recapitalized. Estimating the effect of recapitalizations, while controlling for the level of distress, is key to our analysis. In this section, we explain the identification concerns and how our empirical setup addresses them.

Recapitalized banks may differ from those that are not recapitalized in a number of ways. Firstly, banks that are at some point recapitalized may be intrinsically different from those that are never recapitalized. They may be pursuing riskier strategies, leading to more aggressive growth in normal times, or their monitoring ability may be lower, which may show up in a higher ratio of nonperforming loans in general. We control for this type of time invariant differences by using bank fixed effects.

Secondly, undercapitalized banks are likely to behave differently than adequately capitalized ones. It is therefore critical to control for the initial level of undercapitalization of intervened banks.

We do this by including the level of market implied capital shortfall at the end of the period before a bank is recapitalized, into the regression specifications. This way, recapitalized banks can be compared with banks that are similarly undercapitalized or distressed but are not (yet) intervened or received a recapitalization of different size. Market implied capital shortfall measures how much equity capital a bank would be missing compared to a benchmark market leverage ratio if the economy was hit by a severe shock.² Capital shortfall is computed from the systemic risk measure proposed by Acharya, Engle, and Richardson (2012). Using a market measure has the advantage that it incorporates bank distress promptly and also includes information about losses that are not yet recognized on the balance but are already incorporated into the market valuation. Thus it is likely to be a better measure of undercapitalization than regulatory capital ratios.³

Thirdly, bank recapitalizations are usually done in times when financial sector in general is experiencing distress and the economy is performing worse than in normal times. In such periods loan growth is likely to be lower and asset quality worse. To account for this, we include country specific time fixed effects. They capture distress and also any policy intervention that is not bank specific such as monetary policy, guarantees on bank liabilities etc. To the extent that loan demand varies at country level, country-year fixed effects also capture variation in loan demand.

Finally, an identification concern could be that the regulator always intervenes optimally. If the regulator had perfect information and would be following an optimal intervention policy, the variation in observed intervention could not be exploited. The recapitalizations would be strictly based on the condition of the distressed banks, so the amount of recapitalization would be informative about the distress/undercapitalization not captured by market implied shortfall and other controls but may appear to have little effect on outcome variables. The fact that our dataset includes multiple countries with large variation in recapitalization amounts and timing of recapitalizations, mitigates this concern. In some countries recapitalizations were done early in the

² More details about the capital shortfall measure are provided in the Data section.

³ We perform robustness checks with regulatory ratios.

crisis; in others undercapitalized banks were around for long time.⁴ Also anecdotal evidence suggests that the approaches of regulators differ across countries. This variation insures that there is randomness in recapitalization amounts and timing, which enables us to estimate the effect of recapitalizations, controlling for the factors discussed above.

The estimation equation is the following:

$$\Delta Y_{i,t} = \beta_1 \frac{RECAP_{i,t}}{TA_{i,t-2}} + \beta_2 \frac{RECAP_{i,t-1}}{TA_{i,t-2}} + \beta_3 \frac{STFALL_{i,t-2}}{MVTA_{i,t-2}} + \beta_4 SIZE_{i,t-2} + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

Dependent variable $\Delta Y_{i,t}$ is a change scaled by total assets if $Y_{i,t}$ is a balance sheet item and a change in ratio when $Y_{i,t}$ is itself a ratio; e.g. the change in loans and the change in risk weighted assets ratio are defined as:

$$\Delta LOAN_{i,t} = \frac{LOAN_{i,t} - LOAN_{i,t-1}}{TA_{i,t-1}} \quad (2)$$

$$\Delta RWA / TA_{i,t} = \frac{RWA_{i,t}}{TA_{i,t}} - \frac{RWA_{i,t-1}}{TA_{i,t-1}} \quad (3)$$

In regressions about asset quality the dependent variables are simply the ratios $Y_{i,t}$ (e.g. the ratio of loan loss provisions to total gross loans) and not changes in ratios. Variables $RECAP_{i,t}$ and $RECAP_{i,t-1}$ are recapitalization amounts received by bank i in year t and $t-1$, respectively. There may be multiple recapitalizations in one year if equity injections were done in multiple tranches. Both the sum of recapitalizations in year t and the sum in year $t-1$ are scaled by total assets at the end of year $t-2$, which is just before the first recapitalization may take place. We include both recapitalization variables into the regression specification to differentiate between the immediate effect of recapitalizations and the effect in about a year. More precisely, $RECAP_{i,t}$ is the amount of recapitalization a bank received during the year over which the change in the outcome variable $\Delta Y_{i,t}$ is computed; $RECAP_{i,t-1}$ is the recapitalization amount in the preceding year. Market implied

⁴ For details about recapitalizations of banks in our sample see Table 14 in the Appendix.

capital shortfall $STFALL_{i,t-2}$ divided by the market value of total assets controls for the undercapitalization or distress just before the bank may be intervened.⁵ The control for bank size is the logarithm of total assets, $SIZE_{i,t-2} = \ln(TA_{i,t-2})$. Bank fixed effects are denoted by γ_i ; δ_t are either year fixed effects or country specific year fixed effects. We estimate the regressions using a within estimator that provides Driscoll-Kraay (1998) standard errors. The estimates are identical to the OLS within estimator, while the standard errors are robust against heteroscedasticity, autocorrelation and cross-sectional dependence of residuals. We use the procedure by Hoechle (2007), who modified Driscoll-Kraay (1998) estimator to make it suitable for unbalanced panels.

3 Data

We start by collecting data on bank recapitalizations in European countries that experienced significant bank distress during the recent global financial crisis.⁶ To be able to control for the level of distress of recapitalized banks, we match the recapitalized banks with market implied capital shortfall data provided by Acharya, Engle, and Richardson (2012)⁷; the latter limits the sample to publicly traded banks. With our empirical setup, we can investigate the effect of recapitalizations only on banks that are publicly traded at the time just before they are intervened. It is, however, not necessary for the banks to be publicly traded after the intervention. In addition to the recapitalized banks, our sample includes banks that were not recapitalized and were publicly traded sometime during the period of 2000 to 2013 in countries where at least one publicly traded bank was recapitalized during that period. Finally, we combine the data on recapitalizations and capital shortfalls with bank balance sheet and other data from Bureau van Dijk BankScope database. We begin this section by describing the data on bank recapitalizations. Subsequently, we provide variable definitions and discuss some descriptive statistics.

⁵ Market value of total assets $MVTA$ is computed as the sum of market value of equity and book value of total liabilities.

⁶ In addition to most of the EU member states these include Iceland, Russia, Switzerland and Ukraine.

⁷ The data are available on their website <http://vlab.stern.nyu.edu> at monthly frequency from 2000 onwards.

The primary source of information on bank recapitalizations are decisions of the European Commission about state aid cases. In addition, we use IMF staff reports, webpages of central banks, treasuries and restructuring agencies, and annual reports of banks. There are multiple measures that can be considered a bank recapitalization. When we talk about bank recapitalizations, we have in mind government injections of equity into distressed banks and forced conversions of bank liabilities into equity in the process of bank restructuring. The precise rules are as follows.

Measures counted as recapitalization:

- Injections of common equity, preferred stock, conditionally convertible bonds or any Tier 1 qualifying instrument by a state, a bank restructuring agency or other government agency.
- Conversions of subordinated debt or other bank liabilities into equity (often called liability management exercises). A necessary condition for such a measure to be counted as a recapitalization is that the creditors get a Tier 1 qualifying instrument in exchange for their former claim. The amount counted as recapitalization is the notional value of the new claim, not the amount of the original claim.⁸

Measures not counted as recapitalization:

- Any securities purchased by private investors even if the state has participated in the same issue. Only the amount purchased by the state is counted. A broader definition of bank recapitalizations could include issues of equity to private investors that are a result of regulatory intervention. We do not analyze them as it is difficult to draw a line between a normal equity issue and an issue done because of regulatory pressure.
- Injections of subordinated debt or any Tier 2 qualifying instrument.
- Write-offs of bank liabilities where creditors do not get any security in exchange for giving up their claim. These write-offs are sometimes referred to as the contribution of bondholders to recapitalization. One may argue that such a write-off is similar to a

⁸ If the value of the new claim is not available, we use the amount of liabilities converted.

conversion of liabilities into equity, which is then used to absorb the losses. The important difference is that in case of a write-off the value is written-off immediately and the creditors cannot participate in the upside, while with a conversion to equity losses are offset more gradually and there is a possibility of an upside.

- Compensation for the funding gap in purchase and assumption deals. When the value of liabilities of the acquired bank exceeds its value of assets, the state or a government agency typically compensates the acquirer for the funding gap to facilitate the deal. We do not count this transfer as a recapitalization since it only benefits the creditors of the bank whose claims would otherwise have to be written off before the acquirer would be willing to purchase the distressed bank.
- Value of guarantees on bank assets, CDS, swaps or other instruments provided by governments, which insure a bank against losses from specific assets. This protection has a capital relief effect (it reduces the required regulatory capital, which a bank needs to hold for those assets) and may increase the market value of bank equity.⁹ We do not count the value of these measures as recapitalization since our analysis focuses on intervention where the party that recapitalizes a bank gets equity or equity-like securities in exchange for its contribution.

Our original dataset of recapitalizations includes 90 recapitalized banks, both private and publicly traded, from 22 European countries. Of these we can analyze 41 that were publicly traded at the time when they received their first recapitalization. Because of this limitation the number of countries drops to 15 as in some countries none of the recapitalized banks were publicly traded at the time of intervention.¹⁰ Table 14 in the Appendix provides details about the 41 banks that are

⁹ The value of such measures is difficult to estimate. For an example see Van Wijnbergen and Treur's (2011) valuation of a swap agreement between ING and the Dutch Government.

¹⁰ Banks from Denmark, Hungary, Iceland, Luxembourg, Russia, Sweden and Ukraine are included in our initial dataset of recapitalizations but drop out once we require the analyzed banks to be publicly traded.

part of our analysis. For each bank we report the date of the recapitalization measure, the amount in original currency and provide a short description of the intervention measures.

Table 1: Descriptive statistics.

Variable	N	Mean	St. dev.	Min	Median	Max	Mean, recap. banks	Mean, nonrecap. banks	Diff. recap. vs. nonrecap.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total assets	1,319	231,967	455,742	2.2369	38,596	3,220,271	218,669	162,298	56,370**
Book equity	1,319	10,934	22,516	-2,324	1,987	227,429	9,018	8,161	857
Market capitalization	1,006	13,037	22,646	27.7399	2,818	159,468	15,743	13,277	2,466
Market value of TA	1,006	280,342	497,957	904	51,772	3,139,847	269,814	220,395	49,419
SRISK	1,006	8,761	27,054	-96,932	356	192,093	5,275	2,265	3,010*
Capital shortfall/ MVTA	1,006	0.0233	0.0260	0.0000	0.0119	0.0798	0.0198	0.0124	0.0073***
Recap/ TA	41	0.0380	0.0656	0.0015	0.0133	0.2675			
Recap/ shortfall	40	0.6160	1.0042	0.0200	0.2545	4.4792			
Recap year	41	2010	1.7	2008	2009	2013			
Market leverage ratio	1,006	0.0827	0.0881	0.0045	0.0614	0.7140	0.0795	0.0998	-0.0203***
Book leverage ratio	1,319	0.0685	0.0496	0.0093	0.0621	0.7555	0.0576	0.0725	-0.0150***
Regulatory capital ratio	1,040	0.1273	0.0358	0.0733	0.1180	0.2890	0.1108	0.1222	-0.0114***
Tier 1 ratio	1,050	0.1026	0.0414	0.0530	0.0906	0.2930	0.0852	0.0952	-0.0100***
Loans/ TA	1,319	0.5908	0.1863	0.1033	0.6139	0.9154	0.5542	0.6177	-0.0635***
Gross loans/ TA	1,319	0.6073	0.1916	0.1042	0.6367	1.0840	0.5706	0.6288	-0.0582***
Loans excl. interbank/ TA	1,244	0.5077	0.2073	0.0018	0.5343	0.9071	0.4784	0.5168	-0.0384***
Inter bank lend./ TA	1,295	0.1061	0.0820	0.0022	0.0876	0.6329	0.1038	0.1186	-0.0148**
Govt. securities/ TA	872	0.0719	0.0695	0.0000	0.0587	0.6727	0.0833	0.0552	0.0282***
Risk weighted assets/ TA	711	0.5334	0.1917	0.0000	0.5485	1.0439	0.5658	0.5755	-0.0097
Customer deposits/ TA	1,292	0.4597	0.1790	0.0000	0.4655	0.9165	0.4844	0.4507	0.0337***
Inter bank borrow./ TA	1,293	0.1531	0.1252	0.0000	0.1242	0.7447	0.1341	0.1603	-0.0262***
Senior LT debt/ TA	1,171	0.1448	0.1178	0.0000	0.1221	0.6510	0.1319	0.1578	-0.0258***
Subordinated debt/ TA	1,178	0.0165	0.0123	0.0000	0.0159	0.0930	0.0186	0.0160	0.0026***
Impaired loans/ Gr. loans	990	0.0546	0.0652	0.0011	0.0331	0.3572	0.0386	0.0401	-0.0015
Loan loss prov./ Gr. loans	1,279	0.0103	0.0255	-0.0010	0.0053	0.2213	0.0066	0.0096	-0.0030*
Loan loss reserves/ Gr. loans	1,183	0.0311	0.0267	0.0002	0.0238	0.1512	0.0310	0.0257	0.0054***
Loan charge-offs/ Gr. loans	450	0.0061	0.0074	0.0000	0.0041	0.0481	0.0047	0.0059	-0.0012
Loan recoveries/ Gr. loans	353	0.0038	0.0058	0.0000	0.0009	0.0284	0.0026	0.0036	-0.0010
ROA	1,318	0.5214	1.3699	-4.8600	0.5200	8.6200	0.5672	0.7403	-0.1732**
ROE	1,317	5.6387	18.3913	-105	7.9600	37.2100	9.4663	8.4221	1.0442

Columns (1) – (6) provide descriptive statistics for the full sample. Column (7) reports the mean values of recapitalized banks over the period before they were recapitalized. Column (8) reports the mean values of banks that were not recapitalized; the means are computed over the period 2000-2009 so that the time period approximately matches the one of the recapitalized banks (the median recapitalization year is 2009). Column (9) reports the difference between columns (7) and (8). RECAP/TA and RECAP YEAR refer only to observations of recapitalized banks in the year of recapitalizations. Total assets are denoted as TA and market value of total assets as MVTA. The denominators in asset quality are gross loans. See Table 13 in the Appendix for variable definitions. Values of variables that are not ratios are reported in million EUR. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Market values of bank equity and market implied capital shortfalls are from V-Lab (Acharya, Engle, and Richardson 2012). Capital shortfall of a bank is the gap between the required capital and the actual market value of bank equity in case of a severe shock to the economy that would cause a 40% drop in a broad stock market index over a period of six months. Capital

requirement used to compute the market implied shortfall is in the form of market leverage ratio;¹¹ the benchmark value, which banks need to satisfy also in case of a shock, is 5.5%.¹²

Data on bank loans, funding sources, asset quality and other variables needed for regression analysis come from BankScope financials database. Definitions of these variables are in Table 13 in the Appendix. Table 1 above provides descriptive statistics for variables used in the analysis. Columns (7) and (8) compare banks that were recapitalized with banks that were never recapitalized. For the recapitalized banks, the means are computed over the period before recapitalization. For the non-recapitalized banks the means refer to the period until 2009 so that the period is roughly comparable to the one of the recapitalized banks; the median year in which recapitalizations were done is 2009. The recapitalized and non-recapitalized banks are comparable in terms of asset size. The difference in book value of total assets is statistically significant, while the difference in the market value of total assets is not. The banks that were later recapitalized have on average larger capital shortfall and lower market leverage ratio as well as lower regulatory capital ratios. The difference in market leverage ratio appears to be larger than the differences in regulatory ratios. Recapitalized banks have a lower ratio of loans to total assets and a higher proportion of government securities. There is, however, no significant difference in the ratio of risk weighted to total assets between the recapitalized and non-recapitalized banks. Deposits as a source of funding are slightly more important for the recapitalized banks than for those that were not recapitalized; the latter borrow somewhat more on the interbank market and in the form of senior long term debt. In terms of asset quality, recapitalized banks have higher loan loss reserves relative to gross loans ratio but do not differ in the ratio of impaired loans. Profitability of recapitalized banks measured as return on assets is somewhat lower than of those not recapitalized, while there is no significant difference in return on equity.

¹¹ Market value of bank equity over the sum of market value of equity and book value of total liabilities

¹² This is the default value that Acharya, Engle, and Richardson (2012) use for European banks.

Table 2: Bank recapitalizations

Bank	Country	Year	Total assets [bn]	Recap [bn]	Recap/TA	Capital shortfall	Recap/shortfall	Tier 1 ratio
Erste Group Bank AG	AT	2009	201.71	1.22	0.61	6.33	10.01	9.20
Oesterreichische Volksbanken AG	AT	2009	48.12	1.00	1.79	0.00		9.20
Raiffeisen Bank International AG	AT	2009	76.28	1.75	2.05	5.95	42.39	11.00
Dexia SA	BE	2008	651.01	6.37	1.05	8.28	13.82	10.60
KBC Groep NV	BE	2008	355.32	3.50	0.98	6.53	16.34	8.89
KBC Groep NV	BE	2009	324.23	3.50	0.99	6.50	15.62	10.76
Dexia SA	BE	2012	357.21	5.50	1.33	5.26	18.82	19.90
UBS AG-REG	CH	2008	2014.82	6.00	0.26	3.71	6.90	11.00
Bank of Cyprus Plc	CY	2013	30.34	8.30	26.75	6.02	388.76	10.20
Commerzbank AG	DE	2008	625.22	8.20	1.33	7.12	19.29	10.10
Commerzbank AG	DE	2009	844.10	10.00	1.60	6.96	23.87	10.50
CaixaBank	ES	2010	273.02	0.98				8.92
Banco de Sabadell SA	ES	2011	100.44	5.25	5.41	4.33	151.18	10.17
Banco de Valencia SA	ES	2012	21.50	5.50	24.48	7.61	322.58	
BNP Paribas	FR	2008	2075.55	2.55	0.15	8.82	2.00	7.80
Credit Agricole SA	FR	2008	1653.22	3.00	0.21	8.87	2.70	8.60
Societe Generale	FR	2008	1130.00	1.70	0.16	7.98	2.22	8.43
Natixis	FR	2009	449.22	5.00	0.90	6.91	14.36	9.70
National Bank Of Greece	GR	2011	106.87	1.00	0.83	5.97	15.79	5.30
Piraeus Bank SA	GR	2011	49.35	15.18	26.32	6.55	447.92	5.30
Alpha Bank AE	GR	2012	58.25	1.90	3.21	6.43	48.03	
EFG Eurobank Ergasias SA	GR	2012	67.65	3.97	5.17	6.75	72.22	11.60
National Bank Of Greece	GR	2012	104.80	7.43	6.95	6.23	107.05	6.70
Piraeus Bank SA	GR	2012	70.41	4.70	9.52	6.31	136.67	9.30
Allied Irish Banks PLC	IE	2009	174.31	3.50	1.92	7.74	27.18	7.20
Governor & Co of the Bank of Ireland	IE	2009	181.11	3.50	1.80	7.14	26.05	9.80
Allied Irish Banks PLC	IE	2010	145.22	3.70	2.12	6.15	35.21	5.30
Governor & Co of the Bank of Ireland	IE	2011	154.88	5.30	3.16	6.63	46.04	14.40
Irish Life & Permanent Group Holdings	IE	2011	72.04	2.70	3.57	6.97	49.62	17.90
Banca Monte dei Paschi di Siena SpA	IT	2009	224.82	1.90	0.89	4.72	24.86	7.52
Banca Popolare di Milano Scarl	IT	2009	44.28	0.50	1.11	3.13	38.20	8.62
Banco Popolare SC	IT	2009	135.71	1.45	1.19	5.41	22.43	7.69
Piccolo Credito Valtellinese Scarl	IT	2009	24.90	0.20	0.85	2.17	54.64	6.62
Banca Monte dei Paschi di Siena SpA	IT	2013	199.11	2.00	0.91	5.82	14.75	10.62
ING Groep NV	NL	2008	1331.66	10.00	0.76	8.00	10.29	
SNS REAAL NV	NL	2008	125.36	0.75	0.73	9.64	8.09	
SNS REAAL NV	NL	2013	124.57	2.70	2.02	6.94	30.60	16.60
Banco BPI SA	PT	2012	44.56	1.50	3.49	5.77	58.87	14.90
Banco Comercial Portugues SA	PT	2012	89.74	3.00	3.21	5.95	53.73	11.70
Royal Bank of Scotland Group PLC	UK	2008	2401.65	20.00	1.05	9.64	11.03	10.00
Lloyds Banking Group PLC	UK	2009	1027.26	17.00	3.90	8.25	59.14	9.60
Royal Bank of Scotland Group PLC	UK	2009	1696.49	25.50	1.06	9.52	14.69	14.10

The table lists bank recapitalizations. Total assets and recapitalization amount are reported in billions of national currency. RECAP/TA is recapitalization amount scaled by total assets and reported in percent. Capital shortfall is the market implied capital shortfall before recapitalization. It is reported as a percent of the market value of total assets. Tier 1 capital ratio (in percent) is reported at the end of the year in which a bank was recapitalized.

Table 2 lists all bank recapitalizations and reports the amount of recapitalization relative to total assets, capital shortfall before recapitalization, recapitalization amount relative to capital

shortfall and Tier 1 capital ratio after recapitalization. Recapitalization amount relative to capital shortfall varies widely across banks, ranging from 2% of capital shortfall to 447%. This suggests some banks received only a fraction of what they would need to be adequately capitalized according to the measure of market implied capital shortfall, while others have received a multiple of that amount. Also Tier 1 ratio at the end of the year in which a bank is recapitalized, covers a wide range – from 5.3% of risk weighted assets to 19.9%. This variation suggests approaches to determine the recapitalization amount to be injected into a bank differ a lot across countries. In general banks that received small amounts relative to capital shortfall tended to be the largest banks. Those that had relatively low Tier 1 ratio after the recapitalization were often banks from distressed countries. We discuss the differences between small and large recapitalizations in more detail in the next section where we analyze their effects in a regression framework.

4 Results

This section presents the results of the effect of bank recapitalizations on lending, bank funding sources and asset quality. Table 3 reports the estimations for total gross loans, loans excluding interbank lending, interbank lending, holdings of government securities, risk weighted assets, risk weighted assets ratio and total assets. Gross loans are the amount of loans outstanding. Net loans, which are commonly referred to just as loans, are gross loans reduced by loan loss reserves. Loans excluding interbank lending are our proxy for retail and corporate lending. We differentiate between the immediate effect of recapitalizations and the effect in about a year. Coefficient $RECAP_t$ denotes the effect of recapitalizations injected during the year over which the change in outcome variables is computed. Coefficient $RECAP_{t-1}$ refers to the effect in about a year. Almost a half of recapitalizations in our dataset were implemented in the fourth quarter of the calendar year. Hence, we expect to observe the main effect of recapitalizations in the year after the recapitalizations are done. This is indeed the case. Gross loans as well as loans excluding interbank lending and holdings of government securities increase significantly in the year after

recapitalizations. In the year when recapitalizations are done there is no significant effect on these variables yet. In contrast, there seems to be no significant effect on interbank loans. Higher lending shows up in a significant increase in both risk weighted and total assets. The increase in total assets is relatively larger, leading to a decrease in the ratio of risk weighted to total assets.

To see how banks that should be recapitalized but are not behave, one can look at the effect of capital shortfall. Market implied capital shortfall at $t-2$ is included into regressions to control for the undercapitalization of banks at the time just before they may be recapitalized. The impact of capital shortfall on change in loans, government securities and total assets is negative. Undercapitalized banks tend to grow slower or even shrink their assets. The coefficient on bank size implies that in general large banks grow slower. Bank fixed-effects control for bank specific factors that affect dependent variables in all time periods. Country specific year fixed effects capture the distress that is common to all banks in a country at a certain point in time.

Table 3: Effect of recapitalization on lending and asset growth.

	Gross loans, change (1)	Loans excl. interbank, change (2)	Interbank lending, change (3)	Govt. securities, change (4)	Risk weighted assets, change (5)	Risk w. assets/TA, change (6)	Total assets growth (7)
Recap_t/ TA	-0.1916 (-0.85)	-0.2288 (-1.14)	0.0469 (0.55)	0.0162 (0.34)	0.0702 (0.21)	-0.1412 (-1.11)	0.2637 (0.68)
Recap_t-1/ TA	1.4252*** (12.92)	1.1749*** (7.69)	0.0824 (1.19)	0.3836*** (4.76)	0.7548*** (6.25)	-0.3722*** (-3.62)	2.0550*** (10.24)
Shortfall/ MVTA	-0.5157** (-2.24)	-0.5888* (-1.92)	-0.2512* (-1.95)	-0.3174** (-2.52)	-0.4471 (-1.15)	0.1156 (0.43)	-1.3381*** (-2.95)
ROA	0.0133*** (3.31)	0.0051 (1.00)	-0.0026 (-0.96)	-0.0021 (-0.40)	0.0032 (0.46)	0.0030 (0.41)	0.0106 (0.97)
Size	-0.0975*** (-5.33)	-0.1052*** (-4.11)	-0.0110 (-0.77)	-0.0092 (-0.65)	-0.0864* (-1.94)	0.0136 (0.73)	-0.2140*** (-3.34)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N observations	816	757	801	532	541	541	842
N banks	98	93	95	73	84	84	101
R2: within	0.5839	0.5550	0.2704	0.4166	0.5368	0.2897	0.4901

Dependent variables are changes from year $t-1$ to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t , divided by total assets at $t-2$. RECAP_t-1/TA is the sum of recapitalizations during year $t-1$, divided by total assets at $t-2$. STFALL/MVTA is the capital shortfall at $t-2$ divided by the market value of total assets at $t-2$. For definitions of other variables see Table 13 in the Appendix. In parentheses are t -statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

The effects of recapitalizations on lending are economically significant. Since both the changes in lending and recapitalization amounts are weighted by total assets, the estimated coefficients can be interpreted as follows. Each euro of injected capital leads to 1.42 euro of additional gross loans and 0.38 additional investment in government securities. The mean recapitalization amount is 3.8% of total assets of a bank, which means that as a result of the recapitalization a typical bank increased lending by an amount equivalent to 5.396% of total assets. The average annual change in gross loans of recapitalized banks in the year after recapitalization amounted to 3.83% of total assets, which means that if they were not recapitalized, they would have reduced lending. For comparison, the average change in loans in approximately the same period (2009 to 2013) of banks that were not recapitalized is between 0% and 3% of total assets.¹³

Table 4: Effect of recapitalization on bank funding.

	Customer deposits, change (1)	Interbank borrowing, change (2)	Senior LT debt, change (3)	Subordinated debt, change (4)
Recap_t/ TA	0.0214 (0.20)	0.3137 (1.61)	-0.3572 (-0.91)	0.0173 (0.99)
Recap_t-1/ TA	1.1503*** (7.67)	0.0808 (0.19)	0.0691 (0.97)	0.0023 (0.12)
Shortfall/ MVTA	-0.3346* (-1.96)	-0.1930 (-1.07)	-0.3665* (-1.94)	0.0085 (0.30)
ROA	0.0043 (0.93)	0.0024 (0.84)	0.0085* (1.77)	-0.0003 (-0.39)
Size	-0.0570** (-2.04)	-0.0438*** (-2.95)	-0.0452*** (-2.71)	-0.0014 (-0.45)
Country-year FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
N observations	798	800	770	725
N banks	96	97	98	93
R2: within	0.4399	0.2467	0.3873	0.3563

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. STFALL/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 13 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

¹³ The averages of selected variables over time are reported in Table A13 and Table A14 in the Online Appendix available at www.uva.nl/profile/t.homar.

Table 4 reports the results on how recapitalizations affect banks' ability to raise different types of funding. The dependent variables are changes in the amount of funding sources weighted by total assets. In the year following a recapitalization banks attract significantly more deposits. The effect on other types of funding – interbank borrowing, senior long term debt and subordinated debt – do not appear to be significant. The effect that recapitalized banks attract more deposits is also observed by Berger et al. (2014) on a sample of German banks between 1999 and 2009.

Table 5: Effect of recapitalization on measures of asset quality.

	Impaired loans/ Gr. loans (1)	Loan loss prov./ Gr. loans (2)	Loan loss reserves/ Gr. loans (3)	Loan charge- offs/ Gr. loans (4)	Loan recoveries/ Gr. loans (5)
Recap_t/ TA	-0.0329 (-0.50)	0.2665** (2.70)	0.0624 (1.27)	0.0042 (0.20)	-0.0270* (-1.86)
Recap_t-1/ TA	-0.1031 (-1.58)	-0.0503* (-1.77)	0.1079** (2.34)	0.0343** (2.27)	-0.0106 (-0.84)
Shortfall/ MVTA	0.5295*** (3.24)	0.0840** (2.52)	0.1476*** (3.35)	0.0216 (1.00)	-0.0056 (-0.36)
ROA	-0.0063*** (-3.00)	0.0009 (1.28)	-0.0024** (-2.47)	-0.0004 (-0.37)	0.0001 (0.23)
Size	0.0093 (1.45)	0.0031* (1.96)	-0.0004 (-0.15)	0.0016 (0.50)	-0.0010 (-0.51)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
N observations	700	792	764	362	295
N banks	89	95	95	69	60
R2: within	0.7988	0.6662	0.7916	0.3711	-0.0059

RECAP_t/TA is the sum of recapitalizations during year t, divided by the total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided total assets at t-2. STFALL/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 13 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 5 presents the regression results on asset quality. The results suggest banks begin cleaning up balance sheets immediately when they are recapitalized and continue it in the subsequent year. In general over all time periods, banks with larger capital shortfall have higher ratios of impaired loans, loan loss provisions and loan loss reserves to total gross loans. In the year when a bank is recapitalized it makes significantly more loan loss provisions. In the year after the recapitalization it provisions less, while the loan loss reserves are still higher and can be used to

offset the loan charge offs, which are significantly higher in the year after the recapitalizations. Loans recoveries tend to be lower in the year of recapitalization but do not differ afterwards.

Giannetti and Simonov (2013) find that equity injections had a different effect on Japanese banks when they were large than in case when a bank was still undercapitalized after receiving an injection. Large recapitalizations increased lending, while small recapitalizations led to more evergreening of loans to zombie firms. To check for this effect, we distinguish between banks that have received a small injection relative to their capital needs and banks that received a larger one. We sort banks according to the size of the received recapitalization relative to their capital shortfall before the recapitalization and create a dummy for banks in the bottom quartile. These banks received a recapitalization equal to less than 14.69% of their capital shortfall prior to the recapitalization. The median recapitalization amount is 26.05% of capital shortfall, while the 75th percentile is 58.87%, which is close to the mean of 61%. We classify banks in the bottom quartile as a group receiving small recapitalizations and those in the upper three quartiles as receiving large recapitalizations.¹⁴

To illustrate the differences between the two groups we plot mean capital and leverage ratios for both groups before and after recapitalization in Figure 1, and for a selection of outcome variables in Figure 2. Time $t=0$ marks the end of the year in which a bank is recapitalized. Most banks were recapitalized toward the end of the year, which is indicated with a grey vertical line in the graphs. Book leverage ratio, (book value of equity over total assets) is falling before recapitalization and increases after. The increase is noticeably larger for bank that get a large recapitalization. Similarly, market leverage ratio (market value of equity divided by the sum of market value of equity and book value of liabilities) increases substantially after large recapitalizations and less after small.¹⁵ In contrast there is no visible difference between the two

¹⁴ Recapitalization amounts relative to capital shortfall for all recapitalizations are reported in Table 2.

¹⁵ The increase appears to happen from $t=0$ to $t=1$, which is in the year after the recapitalization, and not in the year of recapitalization between $t=-1$ and $t=0$. This is likely due to the fact that, we do not observe the lowest point for market leverage ratio, which is presumably reached somewhere between $t=-1$ and $t=0$, just before the recapitalization.

groups in Tier 1 ratio. For both the average Tier 1 ratio increases from approximately 8% at $t = -1$ to about 12% at $t = 1$. Since Tier 1 ratio is computed over risk weighted assets, this suggest banks that receive smaller injections increase their risk weighted assets relatively less (or reduce them more) than those that receive larger amounts. Capital shortfall, which to a large extent resembles the inverse of market leverage ratio, decreases after recapitalization.

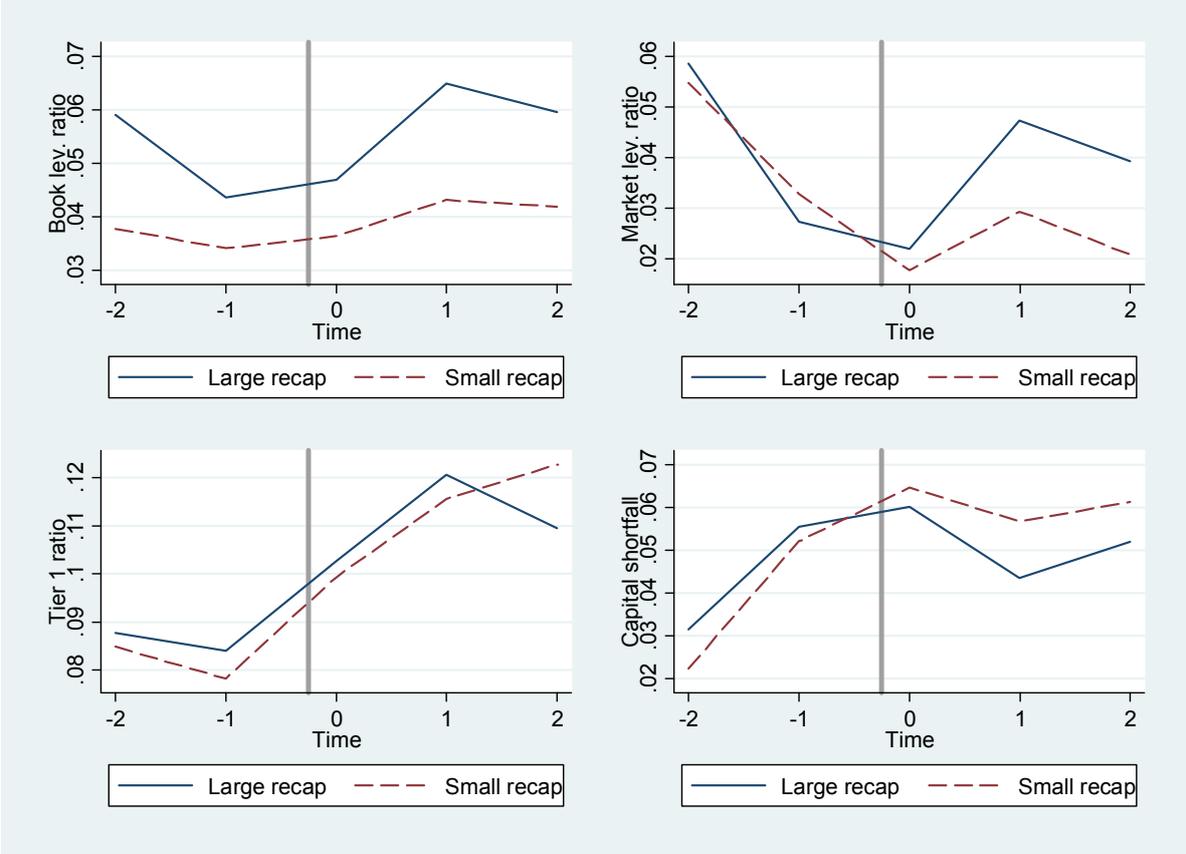


Figure 1: Mean book leverage ratio, market leverage ratio, Tier 1 ratio and capital shortfall for banks that received large or small recapitalizations relative to their capital shortfall.

Book leverage ratio is book value of equity divided by total assets. Market leverage ratio is market value of equity divided by the sum of market value of equity and book value of liabilities. Tier 1 ratio is Tier 1 capital divided by risk weighted assets. Capital shortfall is the market implied capital shortfall divided by the sum of market value of equity and book value of liabilities. Time $t=0$ denotes the end of the year in which a bank was recapitalized. Bank recapitalizations were implemented between time $t=-1$ and $t=0$. Most banks received the recapitalization toward the end of the year, which is marked by a grey vertical line. Red dashed lines plot the mean values for banks that received a SMALL recapitalization relative to their capital shortfall. These are banks in the bottom quartile of received recapitalization amount relative to their capital shortfall before recapitalization. Banks in the upper three quartiles of recapitalization relative to capital shortfall are classified as receiving a LARGE recapitalization (blue lines).

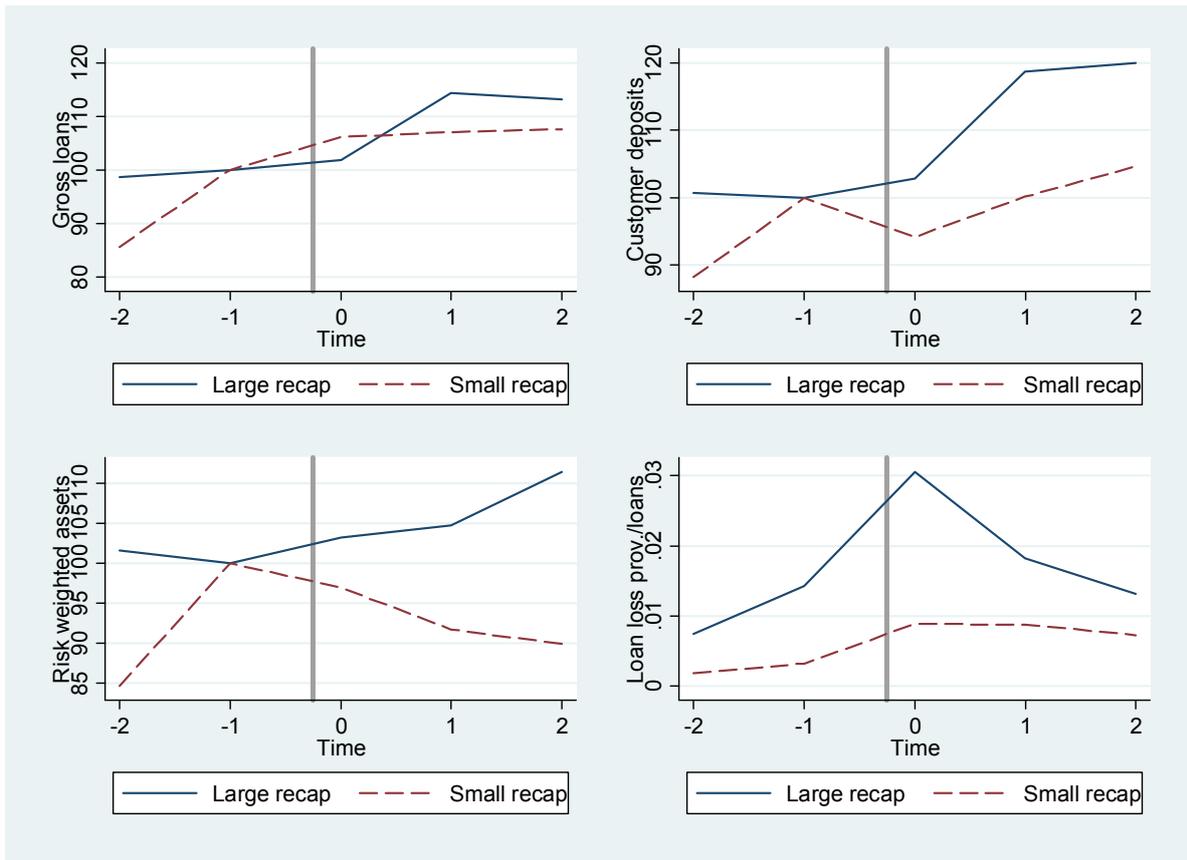


Figure 2: Mean index values of gross loans, customer deposits and risk weighted assets, and loan loss provisions to gross loans ratio for banks that received a large or a small recapitalization relative to their capital shortfall.

Time $t=0$ denotes the end of the year in which a bank was recapitalized. Bank recapitalizations were implemented between time $t=-1$ and $t=0$. Most banks received the recapitalization toward the end of the year, which is marked by a grey vertical line. For gross loans, customer deposits and risk weighted assets mean values of indices with the base at $t=-1$ are plotted. For loan loss provisions ratio, means of actual values are plotted. Red dashed lines plot the mean values for banks that received a SMALL recapitalization relative to their capital shortfall. These are banks in the bottom quartile of received recapitalization amount relative to their capital shortfall before recapitalization. Banks in the upper three quartiles of recapitalization relative to capital shortfall are classified as receiving a LARGE recapitalization (blue line).

Figure 2 depicts gross loans, customer deposits, risk weighted assets and loan loss provisions for both groups of banks. For loans, deposits and risk weighted assets, we plot mean index values with the base at $t=-1$, which is at the beginning of the year in which recapitalizations are implemented. For loan loss provisions, mean values of the ratio are plotted. Banks that receive smaller recapitalizations exhibit a larger loan growth before the recapitalization year, whereas they increase gross loans less following the recapitalization. Interestingly, in the year of recapitalization customer deposits fall in banks that received small injections, while they increase in banks that got larger injections, suggesting that depositors do not perceive small recapitalizations to be sufficient to

reassure them. A large recapitalization enabled banks to increase risk weighted asset while following a small recapitalization, banks shrink their risk weighted assets. Furthermore, banks getting a large injection make more loan loss provisions in the year of recapitalization and need to provision less in the following year. In contrast, the increase in loan loss provisions is less pronounced and more gradual with a small injection.

In Table 6 and Table 7 we investigate these effects in a regression framework. We interact the dummy for small recapitalizations with variables for recapitalization amount to allow for a different effect of injected equity when the injection is small relative to the capital shortfall. Table 6, which can be compared to Table 3, reports the results for lending and asset growth.

Table 6: Effect of recapitalization on lending and asset growth, with interaction term for small recapitalizations.

	Gross loans, change (1)	Loans excl. interbank, change (2)	Interbank lending, change (3)	Govt. securities, change (4)	Risk weighted assets, change (5)	Risk w. assets/TA, change (6)	Total assets growth (7)
Recap_t/ TA	-0.1976 (-0.88)	-0.2407 (-1.22)	0.0428 (0.51)	0.0186 (0.39)	0.0681 (0.20)	-0.1410 (-1.07)	0.2502 (0.64)
Recap_t/ TA * small	1.5327 (0.68)	4.3468*** (3.92)	0.5317 (0.29)	-2.5564 (-1.33)	-1.2831 (-0.59)	1.6297 (0.87)	-2.2716 (-0.28)
Recap_t-1/ TA	1.4335*** (13.24)	1.1795*** (7.89)	0.0881 (1.15)	0.3842*** (4.81)	0.7617*** (6.13)	-0.3777*** (-3.64)	2.0950*** (9.93)
Recap_t-1/ TA * small	-2.5929* (-1.96)	-5.6053*** (-3.87)	-1.9720 (-1.09)	1.6934 (1.25)	-2.6540 (-1.06)	1.8485 (0.61)	-10.7256** (-2.23)
Shortfall/ MVTA	-0.5031** (-2.22)	-0.5669* (-1.87)	-0.2384* (-1.77)	-0.3152** (-2.44)	-0.4296 (-1.09)	0.1017 (0.36)	-1.2378*** (-2.75)
ROA	0.0131*** (3.20)	0.0045 (0.84)	-0.0028 (-1.03)	-0.0017 (-0.32)	0.0029 (0.43)	0.0032 (0.42)	0.0101 (0.94)
Size	-0.0965*** (-5.19)	-0.1025*** (-3.95)	-0.0099 (-0.66)	-0.0097 (-0.67)	-0.0825* (-1.93)	0.0105 (0.60)	-0.2081*** (-3.31)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N observations	816	757	801	532	541	541	842
N banks	98	93	95	73	84	84	101
R2: within	0.5846	0.5577	0.2717	0.4182	0.5377	0.2909	0.4926

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. STFALL/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. The interaction term SMALL is an indicator for a bank that received a small recapitalization given its shortfall. The indicator has value 1 for recapitalized banks that are in the bottom quartile of recapitalization relative to capital shortfall. For definitions of other variables see Table 13 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Controlling for other factors, a small recapitalization leads banks to reduce gross loans. Banks that receive a large recapitalization increase loans by a factor of 1.43 of the injected amount in the year after recapitalization, while banks that get a small recapitalization reduce the loans outstanding by a factor of 1.16 of the injected amount. Similarly, they reduce loans excluding interbank lending. The coefficients with interaction term are not significant for interbank lending, holdings of government securities and risk weighted assets. For total assets the difference between small and large recapitalizations is substantial. These results suggest that it matters how large a recapitalization is relative the capital needs of a bank. For small recapitalizations relative to the capital shortfall, a larger recapitalization amount leads to a greater reduction in lending. Once the recapitalizations are large enough, the relationship becomes positive. A possible explanation is that if the recapitalization is very small relative to the capital shortfall, it does not have much of an effect. If the recapitalization is a bit larger, but still far from what is needed for the bank to become adequately capitalized, the restructuring of the bank is done through cutting back on lending and reducing risk weighted assets. Only when recapitalizations are sufficiently big, a larger recapitalization amount results in a greater increase in lending. We also check whether there is a different effect of recapitalization amount for recapitalizations that are in the top quartile relative to capital shortfall but do not find a significant effect there.

Table 7 presents the results with interaction term for funding sources and asset quality.¹⁶ Bank that receive a small recapitalization suffer a significant drop in customer deposits and are able to borrow less on the interbank market in the year when the recapitalization is implemented. This suggests that too small recapitalizations raise doubts by depositors and investors, which makes it more difficult for the intervened banks to secure funding. In the year after recapitalization, however, these banks raise significantly more senior long term debt. The coefficients with

¹⁶ Compared to Table 4 and Table 5 we omit results for subordinated debt, loan charge-offs and loan recoveries to combine the regressions about funding sources and asset quality in one table. The coefficients with interaction term are not significant in the omitted regressions.

interaction terms in regressions about asset quality show that with a small recapitalization banks report less impaired loans and make less provisions in the year of recapitalization. In the year after recapitalization they have lower impaired loans as well as lower loan loss reserves. These results imply that banks that get small recapitalizations tend to have better asset quality or that the recapitalization amount is too low to induce a serious balance sheet clean up.

Table 7: Effect of recapitalization on bank funding and measures of asset quality, with interaction term for small recapitalizations.

	Customer deposits, change (1)	Interbank borrowing, change (2)	Senior LT debt, change (3)	Impaired loans/ Gr. loans (5)	Loan loss prov./ Gr. loans (6)	Loan loss reserves/ Gr. loans (7)
Recap_t/ TA	0.0237 (0.22)	0.3096 (1.59)	-0.3475 (-0.89)	-0.0355 (-0.54)	0.2664** (2.69)	0.0617 (1.25)
Recap_t/ TA * small	-4.6179*** (-2.99)	-4.0234*** (-2.77)	0.7248 (0.28)	-0.9785* (-2.02)	-0.3071*** (-2.86)	-0.5429* (-1.90)
Recap_t-1/ TA	1.1547*** (7.93)	0.0917 (0.21)	0.0491 (0.65)	-0.0991 (-1.43)	-0.0497* (-1.69)	0.1095** (2.28)
Recap_t-1/ TA * small	-1.4395 (-0.71)	-3.9844 (-1.67)	5.3268*** (3.96)	-1.9370*** (-4.17)	-0.2143 (-1.34)	-0.6648*** (-2.99)
Shortfall/ MVTA	-0.3055* (-1.74)	-0.1432 (-0.83)	-0.4199** (-2.21)	0.5483*** (3.20)	0.0871** (2.51)	0.1548*** (3.33)
ROA	0.0043 (0.94)	0.0021 (0.76)	0.0088* (1.83)	-0.0064*** (-3.13)	0.0009 (1.27)	-0.0024** (-2.45)
Size	-0.0541* (-1.92)	-0.0395*** (-2.84)	-0.0486*** (-2.88)	0.0113* (1.81)	0.0033* (1.96)	0.0003 (0.09)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
N observations	798	800	770	700	792	764
N banks	96	97	98	89	95	95
R2: within	0.4430	0.2525	0.3913	0.7998	0.6668	0.7924

Dependent variables referring to funding are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. STFALL/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. The interaction term SMALL is an indicator for a bank that received a small recapitalization given its shortfall. The indicator has value 1 for recapitalized banks that are in the bottom quartile of recapitalization relative to capital shortfall. For definitions of other variables see Table 13 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

As an alternative measure of undercapitalization, we look at Tier 1 capital ratio at the end of the recapitalization year. Instead of on the injected amount relative to capital needs, this measure is based on the outcome of the recapitalization. Banks with a higher Tier 1 ratio are better capitalized than those with a lower one. Again we sort banks into quartiles and create a dummy for

banks in the bottom quartile with the lowest Tier 1 ratio. In Table 8 and Table 9 we interact the dummy with recapitalization amount to check whether the effect of injected recapitalization amount differs for banks with low Tier 1 ratio. The threshold between banks with low and high Tier 1 ratio is at 8.5 %.

Table 8: Effect of recapitalization on lending and asset growth, with interaction term for low Tier 1 ratio after recapitalization.

	Gross loans, change (1)	Loans excl. interbank, change (2)	Interbank lending, change (3)	Govt. securities, change (4)	Risk weighted assets, change (5)	Risk w. assets/TA, change (6)	Total assets growth (7)
Recap_t/ TA	-0.2004 (-0.55)	-0.3807* (-1.89)	0.1311 (1.36)	0.0115 (0.19)	0.7686*** (3.19)	-0.0710 (-0.32)	0.5363 (0.86)
Recap_t/ TA * low	0.1851 (0.44)	0.4874* (1.98)	-0.1851 (-1.61)	0.0202 (0.19)	-1.0875*** (-4.71)	-0.0771 (-0.35)	-0.5155 (-0.78)
Recap_t-1/ TA	3.0715*** (4.15)	2.2568** (2.41)	0.3601 (1.37)	0.4673** (2.65)	2.1393*** (3.20)	0.1898 (0.38)	3.7946*** (2.89)
Recap_t-1/ TA * low	-1.8714*** (-3.26)	-1.1522 (-1.47)	-0.3575 (-1.39)	-0.0899 (-0.65)	-1.8765*** (-3.88)	-0.6664 (-1.61)	-2.1182** (-2.08)
Shortfall/ MVTA	-0.5403** (-2.28)	-0.6010* (-1.93)	-0.2564** (-2.04)	-0.3197** (-2.63)	-0.4306 (-1.11)	0.1158 (0.41)	-1.3775*** (-3.03)
ROA	0.0133*** (3.19)	0.0045 (0.93)	-0.0024 (-0.88)	-0.0022 (-0.40)	0.0047 (0.63)	0.0031 (0.41)	0.0106 (0.94)
Size	-0.0979*** (-5.26)	-0.1065*** (-4.23)	-0.0108 (-0.76)	-0.0093 (-0.65)	-0.0816* (-1.82)	0.0142 (0.73)	-0.2136*** (-3.34)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N observations	816	757	801	532	541	541	842
N banks	98	93	95	73	84	84	101
R2: within	0.5933	0.5609	0.2725	0.4168	0.5571	0.2932	0.4932

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. STFALL/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. The interaction term LOW is an indicator for banks with relatively low Tier 1 ratio after recapitalization. The indicator has value 1 for recapitalized banks that are in the bottom quartile of the distribution of Tier 1 ratio just after recapitalization. For definitions of other variables see Table 13 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 8 shows that banks with low Tier 1 ratio increase lending after recapitalization but significantly less than banks with higher Tier 1 ratio. The variable where banks with low Tier 1 ratio differ most is risk weighted assets. They shrink risk weighted assets in the year in which recapitalization is implemented and increase them slightly but significantly less than other banks in the following year. This effect is present also for total assets. The results are in line with the findings

of Kok and Schepens (2013) who analyze adjustment of banks toward target equity and Tier 1 ratios and find that reshuffling of risk weighted assets is the main adjustment method, and is particularly important for seriously undercapitalized banks.

Table 9: Effect of recapitalization on bank funding and measures of asset quality, with interaction term for low Tier 1 ratio after recapitalization.

	Customer deposits, change (1)	Interbank borrowing, change (2)	Senior LT debt, change (3)	Impaired loans/ Gr. loans (4)	Loan loss prov./ Gr. loans (5)	Loan loss reserves/ Gr. loans (6)
Recap_t/ TA	0.2555* (1.81)	0.4808 (1.67)	-0.8112*** (-3.47)	-0.0108 (-0.18)	0.2623 (1.59)	0.1267*** (3.75)
Recap_t/ TA * low	-0.5277*** (-2.88)	-0.2753 (-0.81)	0.8969*** (4.10)	-0.0268 (-0.54)	0.0118 (0.07)	-0.1368*** (-3.20)
Recap_t-1/ TA	1.7910*** (3.04)	1.5544*** (2.76)	-0.0945 (-0.34)	0.1941 (1.63)	-0.0383 (-0.67)	0.3665*** (9.70)
Recap_t-1/ TA * low	-0.8442* (-1.86)	-1.7584*** (-6.16)	0.3600 (1.14)	-0.3465*** (-3.35)	-0.0115 (-0.48)	-0.3244*** (-5.66)
Shortfall/ MVTA	-0.3472* (-1.88)	-0.2149 (-1.20)	-0.3340* (-1.73)	0.5254*** (3.28)	0.0839** (2.49)	0.1428*** (3.38)
ROA	0.0046 (0.97)	0.0027 (1.00)	0.0084* (1.74)	-0.0062*** (-3.02)	0.0009 (1.35)	-0.0023** (-2.36)
Size	-0.0563* (-2.03)	-0.0438*** (-2.98)	-0.0464*** (-2.76)	0.0093 (1.50)	0.0030** (2.09)	-0.0003 (-0.10)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
N observations	798	800	770	700	792	764
N banks	96	97	98	89	95	95
R2: within	0.4457	0.2643	0.3960	0.7996	0.6662	0.7971

Dependent variables referring to funding are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. STFALL/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. The interaction term LOW is an indicator for banks with relatively low Tier 1 ratio after recapitalization. The indicator has value 1 for recapitalized banks that are in the bottom quartile of the distribution of Tier 1 ratio just after recapitalization. For definitions of other variables see Table 13 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 9 displays results for bank funding and asset quality. Banks with low Tier 1 ratio after recapitalization suffer a drop in deposits in the year when the recapitalization is implemented and attract less deposits in the subsequent year than banks with higher Tier 1 ratio. They also borrow less on the interbank market. In terms of asset quality banks with low Tier 1 exhibit significantly lower ratio of loan loss reserves to gross loans than banks with high Tier 1 ratio.

5 Robustness checks

This section provides several robustness checks. Our main control of undercapitalization and distress is the market implied capital shortfall ratio. In Table 10 we perform a regression with leverage ratios and regulatory capital ratios as independent variables in place of capital shortfall. In the first column, the same estimation is reported as in the main results in Table 3 to facilitate comparison. In the next columns, market leverage, book leverage, Tier 1 and regulatory capital ratios are used instead of capital shortfall. None of them has a significant effect on lending, while the negative effect of capital shortfall remains significant in most specifications.¹⁷

Table 10: Robustness check, leverage and capital ratios.

	Gross loans, change (1)	Gross loans, change (2)	Gross loans, change (3)	Gross loans, change (4)	Gross loans, change (5)
Recap_t/ TA	-0.1916 (-0.85)	-0.2228 (-0.96)	-0.2185 (-0.87)	-0.2521 (-0.98)	-0.2533 (-0.99)
Recap_t-1/ TA	1.4252*** (12.92)	1.4132*** (11.58)	1.3881*** (10.17)	1.3583*** (9.07)	1.3417*** (9.24)
Shortfall/ MVTA	-0.5157** (-2.24)				
Market leverage ratio		0.0623 (0.60)			
Book leverage ratio			-0.2765 (-1.28)		
Regulatory capital ratio				-0.1954 (-1.57)	
Tier 1 ratio					-0.1668 (-1.14)
ROA	0.0133*** (3.31)	0.0142*** (3.26)	0.0148** (2.31)	0.0140** (2.44)	0.0147** (2.62)
Size	-0.0975*** (-5.33)	-0.0962*** (-4.23)	-0.1093*** (-5.16)	-0.1033*** (-3.42)	-0.1024*** (-3.64)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
N observations	816	816	1112	862	868
N banks	98	98	100	91	93
R2: within	0.5839	0.5799	0.5254	0.5771	0.5715

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. STFALL/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 13 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

¹⁷ We perform regressions including leverage and capital ratios also with other dependent variables. Since leverage and capital ratios are almost never significant, we do not report these regressions.

The sample of analyzed banks runs from 2000 to 2013, while bank recapitalizations only occur after 2007. The observations before 2008 do not contribute to the estimation of coefficients of the effect of recapitalization but may possibly distort them. Furthermore, banks with zero capital shortfall may be too different from the recapitalized banks to be considered a part of the relevant control group.¹⁸ On the other hand, the advantage of a broader sample and a longer time span is that more observations are available for the estimation of bank fixed effects and time fixed effects. To check whether the findings presented in the main results are robust to these concerns, we rerun regressions from Table 3, Table 4 and Table 5: (i) excluding time periods before 2008, (ii) excluding banks with zero capital shortfall and (iii) excluding both the early time periods and banks without shortfall. The results on the effect of recapitalizations remain robust in all three cases.

Table 11: Robustness check, effect of recapitalization on lending and asset growth, the estimation sample is limited to the period of 2008 to 2013 and banks with nonzero capital shortfall.

	Gross loans, change (1)	Loans excl. interbank, change (2)	Interbank lending, change (3)	Govt. securities, change (4)	Risk weighted assets, change (5)	Risk w. assets/TA, change (6)	Total assets, growth (7)
Recap_t/ TA	-0.0573 (-0.29)	-0.1152 (-0.64)	0.0397 (0.33)	-0.0216 (-0.21)	0.1060 (0.29)	-0.1570 (-0.76)	0.2787 (0.64)
Recap_t-1/ TA	1.3577*** (5.74)	1.1143*** (6.64)	0.0953 (0.97)	0.3673*** (3.68)	0.7751*** (3.55)	-0.4909*** (-3.54)	2.0826*** (5.03)
Shortfall/ MVTA	-0.7721** (-2.15)	-0.5750 (-1.21)	-0.2901 (-1.17)	-0.1757 (-0.62)	-0.7915 (-0.84)	0.1385 (0.25)	-0.2757 (-0.15)
ROA	0.0010 (0.22)	-0.0092 (-1.28)	-0.0059* (-1.84)	-0.0090 (-1.07)	-0.0011 (-0.08)	0.0118 (0.86)	-0.0077 (-0.33)
Size	-0.0968 (-1.67)	-0.1212* (-2.10)	-0.0065 (-0.43)	0.0124 (0.58)	-0.1265 (-1.29)	0.0044 (0.09)	-0.2762* (-2.00)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N observations	372	349	372	251	312	312	372
N banks	82	81	82	64	73	73	82
R2: within	0.5082	0.4574	0.2533	0.5091	0.3773	0.2667	0.4552

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. STFALL/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 13 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

¹⁸ Only one recapitalized bank (Oesterreichische Volksbanken AG) did not have a capital shortfall before it was recapitalized.

Table 12: Robustness check, effect of recapitalization on bank funding and measures of asset quality, the estimation sample is limited to the period of 2008 to 2013 and banks with nonzero capital shortfall.

	Customer deposits, change (1)	Interbank borrowing, change (2)	Senior LT debt, change (3)	Impaired loans/ Gr. loans (4)	Loan loss prov./ Gr. loans (5)	Loan loss reserves/ Gr. loans (6)
Recap_t/ TA	0.0966 (0.54)	0.1708 (0.75)	-0.2592 (-1.38)	-0.1065** (-2.39)	0.1890 (1.61)	0.0139 (0.54)
Recap_t-1/ TA	1.1248*** (4.11)	0.0449 (0.09)	-0.0544 (-0.55)	-0.0988 (-0.91)	-0.0489* (-1.93)	0.1103** (2.40)
Shortfall/ MVTA	-0.8279* (-1.87)	-0.1466 (-0.39)	-0.2366 (-1.11)	0.1577 (1.14)	0.1035 (1.73)	0.0247 (0.42)
ROA	-0.0073 (-1.26)	0.0028 (0.45)	-0.0017 (-0.16)	-0.0049 (-0.87)	0.0043** (2.89)	-0.0038 (-1.39)
Size	-0.0898* (-1.96)	-0.0271 (-0.77)	-0.0596*** (-4.15)	0.0072** (2.16)	0.0057** (2.51)	-0.0024 (-0.57)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
N observations	367	370	345	328	366	358
N banks	81	82	78	76	81	81
R2: within	0.5724	0.2768	0.3114	0.8798	0.6569	0.8602

Dependent variables referring to funding are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. STFALL/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 13 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 11 and Table 12 report the results estimated on the smallest sample, which includes only the time period from 2008 to 2013 and banks with nonzero capital shortfall. Table 11 relates to Table 3; regressions in Table 12 can be compared to those in Table 4 and Table 5. Coefficients for bank recapitalizations remain significant and their size does not change much. The only noticeable difference is that the estimated effect of capital shortfall becomes less significant, which is expected given that the banks that remain in the sample are more similar to each other in terms of shortfall.

In the regressions so far, recapitalization amounts are weighted by total assets. Alternatively, recapitalization amounts could be weighted by capital shortfall. Weighting by total assets is more appropriate when each euro of injected equity is expected to have approximately equal effect on an outcome variable. In contrast, weighting by capital shortfall is more appropriate when the rate for which incentives are improved is critical for the effect on outcome variables. To

illustrate the conceptual difference, consider a bank with a capital shortfall equal to 2% of its assets that receives a recapitalization that also amounts to 2% of its assets. If recapitalization amounts are weighted by total assets, the effect of such a recapitalization on lending is expected to be the same as the effect of a recapitalization of 2% of assets injected into a bank with a capital shortfall equal to 1% of its assets, controlling for the level of shortfall and other factors. In the other case when recapitalization amounts are weighted by capital shortfall, such an injection is expected to have the same effect as an injection equal to 1% of bank assets into a bank with a shortfall of 1%. We rerun the regressions from Table 3, Table 4 and Table 5 with recapitalizations weighted by capital shortfall instead of total assets and report them in Table A2, Table A3 and Table A4 (Table 3 compares to Table A2 etc.). To conserve space, we report these tables and the tables of the following robustness checks in the Online Appendix.¹⁹ Comparing the estimates weighted by total assets with those weighted by capital shortfall reveals no noticeable differences. The signs of significant coefficients are identical and their levels of significance are about the same.

Next, we rerun regressions from the main results in Table 3, Table 4 and Table 5 but define outcome variables as relative changes instead of changes weighted by total assets. Thus we look at growth rates of balance sheet components. The specifications with changes weighted by total assets provide information on which balance sheet components have increased or decreased most in absolute terms as a result of recapitalization, while outcome variables defined as relative changes are informative about which items have changed most compared to their initial value. The estimations with outcome variables defined as growth rates are reported in Table A5, Table A6, Table A7 and reflect those in the main results section.

In the main results we use country specific year fixed effects in addition to bank fixed effects. To check whether so many fixed effects may capture too much of the variation in outcome variables, we rerun regressions from Table 3, Table 4 and Table 5 with year fixed effects that are not country specific and report these estimations in Table A7, Table A8 and Table A9. In general

¹⁹ The Online Appendix is available at www.uva.nl/profile/t.homar

the results are similar to those in the main results section. A few differences suggest that country fixed effects and year fixed effects that are not country specific fail to capture part of the distress to which all banks in a country were exposed at a certain time. This shows up in a negative and significant coefficient of the effect of recapitalization on lending in the year in which recapitalization is implemented, a negative effect on deposits and higher impaired loans as well as loan loss reserves in the recapitalization year. Furthermore, the size of the coefficients of capital shortfall tends to be larger, suggesting that when time specific country fixed effects are not included, a part of the general distress in the banking sector is attributed to capital shortfall of individual banks. All of these differences point to the explanation that if the specification does not control for country specific time fixed effects, the results on recapitalizations are polluted by the effect of banking sector-wide distress in a country.

As a final robustness check we report the regressions from Table 3, Table 4 and Table 5 estimated with commonly used White (1980) heteroscedasticity robust standard errors instead of Driscoll-Kraay (1998) standard errors, which are in addition to heteroscedasticity robust also against autocorrelation and cross-sectional dependence and thus preferable. Since Driscoll-Kraay (1998) standard errors are somewhat less well known, we estimate the main regressions also with White (1980) standard errors and report them in Table A10, Table A11, Table A12 (Table A10 compares to Table 3 etc.) The significance levels are in general similar. The values of t-statistics are sometimes higher and sometimes lower than in the main results.

6 Conclusions

Bank recapitalizations are a common form of intervention in systemic banking crises. How large they should be, is often subject to fierce discussions as government equity injections into banks can require a substantial increase in public debt, may lead to moral hazard and could create rents for bank insiders. This paper analyzes how effective recapitalizations are in achieving their objectives at micro level: do they increase lending, improve banks' ability to raise funding and

induce them to clean up balance sheets? And more specifically, is the size of recapitalizations important for their success? Theory suggests there are two inefficiencies that recapitalizations can mitigate. Firstly, undercapitalized banks are likely to lend less or even foreclose on borrowers with whom they have developed valuable relationships in the past. These borrowers cannot simply substitute to another bank because the loans are relationship specific. Secondly, banks close to or below regulatory capital requirements are likely to evergreen loans to nonviable borrowers to avoid prompt recognition of losses.

We analyze bank recapitalizations on a dataset of publicly traded European banks in the period of 2000 to 2013. The dataset provides great variation in regulatory approaches, timing of intervention and recapitalization amounts. Banks that were similarly undercapitalized were subject to different treatment. To control for undercapitalization of banks at the time just before they are intervened, we use market implied capital shortfall of banks, computed from a systemic risk measure developed by Acharya et al. (2012), which enables us to compare recapitalized banks with those that are similarly distressed but were not recapitalized or received an equity injection of different size.

We find that recapitalizations are only effective if they are large enough. Banks that receive a sufficient recapitalization increase lending, attract more deposits and clean up balance sheets. In contrast, banks that receive a small recapitalization, relative to their capital shortfall, suffer a drop in deposits and interbank borrowing, reduce lending and shrink assets. Furthermore, banks that have a relatively low Tier 1 ratio after recapitalization because the injection was small given their capital needs, shrink risk weighted assets and lend less than those with a higher Tier 1 ratio after recapitalization.

The policy implications of our findings are that recapitalizations need to be large enough to lead to new lending instead of an adjustment through shrinking. Giannetti and Simonov (2013) obtain similar results on Japanese banks. They are able to distinguish between lending to creditworthy borrowers, which increases after sufficient recapitalizations, and zombie lending into

which too small recapitalizations are channeled. Our contribution is to provide an analysis of recapitalizations on all main aspects of bank behavior: lending, funding and asset quality. The results show that bank recapitalizations affect all of them and suggest that recapitalizations are beneficial. There are many further questions to explore about the effect of recapitalizations. How much of the increase in lending benefits banks' existing borrowers and how much of it is lending to new customers? Does recapitalization size also affect allocation across risk weight classes? More specifically, do banks that received large injections given their shortfall lend more to SMEs than those that are recapitalized less? Such analysis would require loan level data or very detailed bank balance sheet data – topics for future research.

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APPENDIX

Table 13: Variable definitions.

Variable	Description	BankScope WRDS code
Total assets	Book value of total assets	data2025
Book equity	Book value of equity	data2055
Market capitalization	Market value of equity. Source V-Lab webpage (Acharya, Engle and Richardson 2012)	
Market value of total assets	Market value of total assets is computed as the sum of market value of equity and book value of total liabilities.	
Size	Logarithm of total assets.	
SRISK	SRISK is a measure of systemic risk provided by Acharya, Engle and Richardson (2014). It is the dollar value of market implied capital shortfall that a bank would realize in case of a shock to the economy that would cause a 40% drop in the broad stock market index over a period of 6 months. The values are obtained from V-Lab webpage. The benchmark capital requirement is that a bank should have enough capital such that after the shock its market leverage ratio is at least 5%. A positive value means that a bank has too little capital, while a negative value indicates that a bank has more capital than necessary to be sufficiently capitalized in case of a shock.	
Capital shortfall/ MVTA	Capital shortfall, defined as SRISK divided by market value of total assets if SRISK is positive and zero otherwise.	
Recap/ TA	The sum of bank recapitalizations during a year divided by total assets at the end of the previous year.	
Recap/ shortfall	The sum of bank recapitalizations during a year divided by the capital shortfall at the end of the previous year.	
Recap year	Year when a recapitalization was implemented.	
Market leverage ratio	Market value of equity divided by market value of total assets	
Book leverage ratio	Book equity divided by total assets	
Regulatory capital ratio	Total regulatory capital divided by total assets	data4008
Tier 1 ratio	Tier 1 capital divided by total assets	data4007
Loans	Net loans are denoted simply as "loans". They are equal to gross loans reduced for loan loss reserves.	data2000
Gross loans	Gross loans are in contrast to net loans not reduced for loan loss reserves.	data2001
Loans excl. interb. lending	Net loans excluding loans and advances to banks	data2000-data2180
Interbank lending	Interbank lending (loans and advances to banks)	data2180
Government securities	Holdings of government securities	data11215
Customer deposits	Total customer deposits	data2031
Interbank borrowing	Interbank borrowing (deposits from banks)	data2185
Senior LT debt	Senior debt with maturity longer than 1 year	data11590
Subordinated debt	Subordinated debt	data11600
Impaired loans	Impaired loans	data2170
Loan loss provisions	Loan loss provisions (P&L item)	data2095
Loan loss reserves	Loan loss reserves (balance sheet item, it increases when loan loss provisions are made or when some impaired loans are recovered and decreases when loans are charged off)	data2070
Loan charge offs	Loan charge-offs	data10200
Loan recoveries	Loan recoveries	data30080

The table provides variable names, their definitions or short descriptions, and for BankScope variables the item under which the variable is reported in BankScope Financials database provided by WRDS.

Table 14: Data on bank recapitalizations

Country	Date	Bank	Recap.	Description
Austria	2009 Mar	Erste Group	EUR 1.00 bn	Erste Group: EUR 1bn capital injection in March 2009. Source: Finance Ministry of Austria; Erste Group Annual Report 2009
Austria	2009 Apr	RZB Group	EUR 1.75 bn	RZB group: EUR 1,750m capital injection in April. Source: Finance Ministry of Austria; RZB Group Annual report 2009
Austria	2009 Apr	Österreichische Volksbanken	EUR 1.00 bn	Österreichische Volksbanken: EUR 1bn capital injection in the form of participation certificates in April 2009. Source: State aid SA.31883 (N516/2010)
Austria	2009 May	Erste Group	EUR 0.22 bn	Erste Group: EUR 224m capital injection in the form of participation certificates in May 2009. Source: Finance Ministry of Austria; Erste Group Annual Report 2009
Belgium	2008 Oct	Dexia	EUR 6.37 bn	Dexia: Capital injections of EUR 3bn by Belgian state and regions (Dexia also received EUR 3bn of capital injections from France, and Dexia's Luxembourg subsidiary EUR 376m from Luxembourg in the form of concertible bonds) in October 2008. Source: State aid C 9/2009 (ex NN 49/2008)
Belgium	2008 Dec	KBC	EUR 3.50 bn	KBC: Capital injection of EUR 3.5bn by Belgian state in December 2008. Source: State aid C 18/2009 (ex N 360/2009)
Belgium	2009 Q3	KBC	EUR 3.50 bn	KBC: Capital injections of EUR 3.5bn by Flemish government, approved by the EC on 30 June 2009. Source: State aid C 18/2009 (ex N 360/2009)
Belgium	2012 Dec	Dexia	EUR 5.50 bn	Dexia: Capital injection by Belgium EUR 2.9bn (and France EUR 2.6bn) in December 2012. Source: IMF Country Report No. 13/124; Dexia Annual Report 2012
Cyprus	2012 Jun	Cyprus Popular Bank	EUR 1.80 bn	Cyprus Popular Bank: EUR 1,796m capital injection in June 2012. The state acquires 84% share. Source: State aid SA.34827 (2012/NN)
Cyprus	2013 Mar	Cyprus Popular Bank, Bank of Cyprus	EUR 8.30 bn	Large depositors in Cyprus Popular Bank and Bank of Cyprus bailed-in in March 2013; EUR 8.3bn is the maximum possible contribution of depositors to recapitalization. Source: EC European Economy Occasional Papers 149
France	2008 Dec	BNP Paribas	EUR 2.55 bn	BNP Paribas: Injection of EUR 2.55bn in hybrid instruments (TSS), qualifying as Tier 1 capital, by SPPE in December 2008. The EC approved up to EUR 21bn capital injections under the scheme on 8 December 2012. The first tranche of EUR 10.5 bn was injected on into 6 banks on implemented on 10 December 2008. Source: State aid N 613/2008; NYT : France Implements \$13.6 Billion Bank Aid Plan (11 December 2008)
France	2008 Dec	Credit Agricole	EUR 3.00 bn	Credit Agricole: Injection of EUR 3bn in hybrid instruments (TSS), qualifying as Tier 1 capital, by SPPE in December 2008. Source: State aid N 613/2008
France	2008 Dec	Societe Generale	EUR 1.70 bn	Societe Generale: Injection of EUR 1.7bn in hybrid instruments (TSS), qualifying as Tier 1 capital, by SPPE in December 2008. Source: State aid N 613/2008

France	2009 Q3	BPCE	EUR 5.00 bn	Merger of Banque Populaire and Caisses d'Epargne on 31 July 2009. The merged entity Groupe BPCE received EUR 2bn of super subordinated notes (TSS), issued to BP and CE by SPPE on 26 June 2009, and EUR 3bn preferred of stock injection on 31 July 2009. The most important subsidiary of BPCE is Natixis. Source: State Aid N 249/2009; BPCE Annual Report 2009
Germany	2008 Nov	Commerzbank	EUR 8.20 bn	Commerzbank: Capital injection of EUR 8.2bn by SoFFin in the form of silent participation in November 2008. Source: State aid SA.34539 (2012/N)
Germany	2009 Jan	Commerzbank	EUR 10.00 bn	Commerzbank: Additional capital injection of EUR 8.2bn in silent participation and EUR 1.8bn in ordinary shares in January 2009. Source: IMF Country Report No. 11/368; State aid SA.34539 (2012/N)
Greece	2011 Jun	ATE Bank	EUR 0.58 bn	ATE Bank (Agricultural Bank of Greece): Capital increase EUR 584.5m approved by the EC in May 2011, implemented until end of June 2011. Gross capital injection by the state EUR 1,144.5m of which EUR 675m used to repurchase shares from May 2009 recapitalization. Source: State aid N429/2010
Greece	2011 Nov	ATE Bank	EUR 0.29 bn	ATE Bank: Capital injection of EUR 290m in the form of capital rights in November 2011. Source: State Aid SA.35460 (2013/NN)
Greece	2011 Dec	National Bank of Greece	EUR 1.00 bn	National Bank of Greece: Capital injection of EUR 1bn approved by the EC on 22 December 2011. Source: State aid No SA.34824 (2012/C, ex 2012/NN)
Greece	2011 Dec	Piraeus Bank	EUR 0.38 bn	Piraeus Bank: Capital injection of EUR 380m approved by the EC on 28 December 2011. Source: State aid SA.34122 (2011/N)
Greece	2011 Dec	TT Hellenic Postbank		TT Hellenic Postbank: In December 2011 T Bank was put into liquidation. EUR 2.16bn of its liabilities and EUR 1.483bn of assets were transferred to TT. TT was compensated for the funding gap of EUR 677m (not counted as recap). Source: State aid SA.31155 (2013/C) (2013/NN) (ex 2010/N);
Greece	2012 May	Alpha Bank	EUR 1.90 bn	Alpha Bank: Capital injection of EUR 1.9bn on 28 May 2012 by HFSF. Source: State aid No SA.34823 (2012/C, ex 2012/NN)
Greece	2012 May	EFG Eurobank	EUR 3.97 bn	EFG Eurobank: Capital injection of EUR 3.97bn on 28 May 2012 by HFSF. Source: State aid No SA.34825 (2012/C, ex 2012/NN)
Greece	2012 May	National Bank of Greece	EUR 7.43 bn	National Bank of Greece: Capital injection of EUR 7.43bn on 28 May 2012 by HFSF. Source: State aid No SA.34824 (2012/C, ex 2012/NN)
Greece	2012 May	Piraeus Bank	EUR 4.70 bn	Piraeus Bank: Capital injection of EUR 4.7bn on 28 May 2012. Source: State aid No SA.34826 (2012/C, ex 2012/NN)
Greece	2013 Jan	TT Hellenic Postbank	EUR 0.50 bn	TT Hellenic Postbank: Capital injection of EUR 500m into bridge bank New TT on 18 January 2013 in addition New TT received EUR 4.1bn from HFSF in the form of EFSF bonds to cover the funding gap from the transfer of assets from TT to New TT (not counted as recapitalization). Source: State aid SA.31155 (2013/C) (2013/NN) (ex 2010/N)

Ireland	2009 Mar	Bank of Ireland	EUR 3.50 bn	Bank of Ireland: received a EUR 3.5bn injection of preferred stock in March 2009 (Announced in February, approved by the EC in March), EUR 1.67bn of it was converted into common stock in June 2010. Source: State aid SA.33216 (2011/N); State aid SA.33443 (2011/N)
Ireland	2009 May	Allied Irish	EUR 3.50 bn	Allied Irish Bank: Capital injection of EUR 3.5bn approved by the EC on 12 May 2009. Source: State aid SA.33296 (2011/N)
Ireland	2009 Jun	Anglo Irish	EUR 13.30 bn	Anglo Irish - first recapitalization: Capital injection of EUR 3bn in June 2009 (from EUR 4bn), the remaining EUR 1bn in two tranches in August and September 2009. Source: State aid NN12/2010 and C11/2010 (ex N667/2009)
Ireland	2009 Q3	Anglo Irish	EUR 1.00 bn	Anglo Irish: Capital injection of EUR 1bn in two tranches in August and September 2009 (second part of the EUR 4bn recap). Source: State aid NN12/2010 and C11/2010 (ex N667/2009)
Ireland	2010 May	Anglo Irish	EUR 10.30 bn	Anglo Irish - second recapitalization: Capital injection of EUR 8.3bn and EUR 2bn contingent capital, implemented in May 2010 (recapitalization up to EUR 10.44bn approved by the EC on 31 March 2010). Source: State aid NN 35/2010 (ex N 279/2010)
Ireland	2010 Aug	Anglo Irish	EUR 8.58 bn	Anglo Irish - third recapitalization: Capital injection of EUR 8.58bn (On 10 August 2010 the EC approved a recapitalization of EUR 10.054bn of which EUR 8.58bn was injected, the remaining EUR 1.474bn injected together with the fourth recapitalization). Source: State aid 32504 (2011/N) and C 11/2010 (ex N 667/2009)
Ireland	2010 Dec	Allied Irish	EUR 3.70 bn	Allied Irish Bank: Capital injection of EUR 3.7bn (EC approved a EUR 9.8bn capital injection, the first instalment of EUR 3.7bn was injected in December 2010; the second never took place). Source: State aid SA.33296 (2011/N)
Ireland	2010 Dec	Anglo Irish	EUR 6.42 bn	Anglo Irish - fourth recapitalization: Capital injection of EUR 1.474bn (remaining part from the third recapitalization and a EUR 4.946bn capital injection in December 2010. Source: State aid NN 35/2010 (ex N 279/2010); State aid SA.33296 (2011/N)
Ireland	2011 Jul	Allied Irish & EBS	EUR 14.80 bn	Merger of Allied Irish Bank and EBS: EUR 14.8bn recapitalization provided to facilitate the merger (EUR 5bn by National Pensions Reserve Fund Commission, EUR 6.5bn by Ministry of Finance, EUR 1.6bn contingent capital, EUR 1.7bn from liability management exercises) in July 2011. Source: State aid SA.33296 (2011/N)
Ireland	2011 Jul	Bank of Ireland	EUR 5.30 bn	Bank of Ireland: EUR 200m state participation in a EUR 1.9bn rights issue and EUR 1bn injection of contingent capital in July 2011. Liability management exercises (conversion of liabilities into equity) contributed EUR 2.3-2.5bn of capital. Liability management exercises counted as recap. Private purchase of rights issue not. Source: State aid SA.33216 (2011/N); State aid SA.33443 (2011/N)
Ireland	2011 Jul	Irish Life & Permanent	EUR 2.70 bn	Irish Life & Permanent: Capital injection of EU 2.3bn in the form of ordinary shares and EUR 400m in contingent capital in July 2011. Source: State aid SA.33311 (2011/N)

Italy	2009 Jul	Gruppo Banco Popolare	EUR 1.45 bn	Gruppo Banco Popolare: Capital injection of EUR 1.45 bn in the form of Tier 1 qualifying hybrid instruments in July 2009. Source: State aid N 425/2010
Italy	2009 Dec	Gruppo Banca Popolare Milano	EUR 0.50 bn	Gruppo Banca Popolare Milano: Capital injection of EUR 500m in the form of Tier 1 qualifying hybrid instruments in December 2009. Source: State aid N 425/2011
Italy	2009 Dec	Gruppo Credito Valtellinese	EUR 0.20 bn	Gruppo Credito Valtellinese: Capital injection of EUR 200m in the form of Tier 1 qualifying hybrid instruments in December 2009. Source: State aid N 425/2012
Italy	2009 Dec	Monte dei Paschi di Siena	EUR 1.90 bn	Monte dei Paschi di Siena: Capital injection of EUR 1.9bn in the form of Tier 1 qualifying hybrid instruments in December 2009. Source: State aid N 425/2013
Italy	2013 Jan	Monte dei Paschi di Siena	EUR 2.00 bn	Monte dei Paschi di Siena: Capital injection of EUR 3.9 bn in the form of Tier 1 qualifying hybrid instruments. The recapitalization was approved by the EC on 17 December 2012 and implemented in January. EUR 1.9 bn of the issue was used to replace the December 2009 recapitalization. Source: State aid SA.35137 (2012/N)
Netherlands	2008 Nov	ING	EUR 10.00 bn	ING: Capital injection of EUR 10bn approved on 12 November 2008. On 26 January 2009 ING entered into an a swap agreement under which the Netherlands receive 80% of cash flow from ING's Alt-A RMS portfolio; in exchange ING receives cash flows from a synthetic government bond portfolio (not counted as recapitalization). Source: State aid C 10/2009 (ex N 138/2009)
Netherlands	2008 Dec	SNS Reaal	EUR 0.75 bn	SNS Reaal: Capital injection of EUR 750m approved on 10 December 2008. Source: State aid N 611/2008
Netherlands	2013 Feb	SNS Reaal	EUR 2.70 bn	SNS Reaal: Nationalized on 1 February 2013. The state injected EUR 1.9bn of capital into SNS Bank and EUR 300m into SNS Reaal. In addition EUR 1bn of claims by shareholders and subordinated debt as well as EUR 0.8bn of equity injected by the State in December 2008 were written off (write-offs not counted as recapitalization). The State incurred also EUR 700m costs of isolating real estate portfolio (EUR 500m of these was a capital injection into a new real estate vehicle). Source: State aid SA.35382 (2013/N); Kamerbrief over de onteigening van SNS Reaal (Letter of Dutch Finance Ministry about Nationalisation of SNS Reaal)
Portugal	2012 Jun	BCP	EUR 3.00 bn	Banco Comercial Português: Capital injection of EUR 3bn in the form of hybrid securities in June 2012 under the Portuguese recapitalization scheme. Source: EC Press Release: State aid: Commission finalises discussions on restructuring plans for Portuguese banks CGD, Banco BPI, BCP (24 July 2013)
Portugal	2012 Jun	Banco BPI	EUR 1.50 bn	Banco BPI: Capital injection of EUR 1.5bn in the form of hybrid securities in June 2012 under the Portuguese recapitalization scheme. Source: EC Press Release: State aid: Commission finalises discussions on restructuring plans for Portuguese banks CGD, Banco BPI, BCP (24 July 2013)
Portugal	2013 Jan	Banif	EUR 1.10 bn	Banif (Banco Internacional do Funchal): Capital injection of EUR 1.1bn (EUR 700m in shares and EUR 400m in hybrid securities) in January 2013. Source: EC Press Release: State aid: Commission temporarily approves rescue recapitalisation of Portuguese bank Banif (21 January 2013)

Slovenia	2013 Dec	Probanka	EUR 0.24 bn	Probanka: Capital injection of EUR 236m in the process of orderly winding down of the bank, approved by the EC and implemented in December 2013. Source: EC Press release: State aid: Commission approves rescue or restructuring for five Slovenian banks. (18 December, 2013)
Spain	2010 Apr	Caixabank	EUR 0.98 bn	Caixabank: Convertible preference shares injection of EUR 0.977m in April 2010 by FROB. Source: Fondo de Reestructuracio Ordenada Bancaria (Slides from FROB webpage, April 2013)
Spain	2010 Jun	Bankia-BFA	EUR 4.47 bn	Bankia-BFA: Convertible preference shares injection of EUR 4.465 m in June 2010 by FROB. Source: State aid SA.34820 (2012/N)
Spain	2011 Dec	Sabadell	EUR 5.25 bn	Sabadell received EUR 5,249m capital injection from the Deposit Guarantee Fund in December 2011. Source: Fondo de Reestructuracio Ordenada Bancaria (Slides from FROB webpage, April 2013)
Spain	2012 Jun	Banco de Valencia	EUR 1.00 bn	Banco de Valencia: Injection of EUR 1bn of ordinary shares by Frob in June 2012. Source: State aid SA.34053 (2012/N)
Spain	2012 Dec	Banco de Valencia	EUR 4.50 bn	Banco de Valencia: Injection of EUR 4.5bn of CoCo bonds by FROB, approved by the EC and implemented in December 2012. Source: State aid SA.34053 (2012/N)
Spain	2012 Dec	Bankia-BFA	EUR 17.96 bn	BFA-Bankia: Injection of EUR 17,959m of CoCo bonds by FROB, approved by the EC and implemented in December. Source: State aid SA.34820 (2012/N)
Switzerland	2008 Dec	UBS	SFR 6.00 bn	UBS: Capital injection of SFR 6bn in the form of mandatory convertible notes (MCN) on 9 December 2008. Source: IMF Country Report No. 09/164; UBS Annual Report 2008
United Kingdom	2008 Oct	Royal Bank of Scotland	GBP 20.00 bn	Royal Bank of Scotland: Capital injection of GBP 15bn in ordinary shares and GBP 5bn in preference shares in October 2008. In January preference shares were converted into ordinary shares. Source: State aid No N 422/2009 and N 621/2009
United Kingdom	2009 Jan	Lloyds Banking Group	GBP 17.00 bn	Lloyds Banking Group: Capital injection of GBP 13bn in ordinary shares and GBP 4bn in preference shares, implemented on 20 January 2009. In June 2009 Lloyds issued GBP 4bn of ordinary shares to redeem the preference shares. GBP 1.7bn of these issue was bought by HM Treasury, which resulted in the total injection being reduced from GBP 17bn to GBP 14.7bn. Source: State aid No. N 428/2009
United Kingdom	2009 Dec	Royal Bank of Scotland	GBP 25.50 bn	Royal Bank of Scotland: Further capital injections of GBP 25.5bn in non-voting B shares, approved by EC in December 2009. In addition a five year contingent commitment of HM Treasury to inject GBP 8bn of B shares in case Core Tier 1 ratio falls below 5% was approved by EC and implemented in December 2009. Source: State aid No N 422/2009 and N 621/2009; RBS Annual Report 2009