Recapitalization, Credit and Liquidity

SUMMARY

This paper documents the characteristics of public recapitalizations of banks undertaken since 2008 and examines their relationship with bank lending. The analysis covers the 15 OECD countries whose banking sectors were most severely hit by the crisis and that provided the largest public bailouts relative to their national gross domestic product (GDP). We show that the design of the interventions varied considerably across banks and countries. Larger and higher loss-absorbing capital injections were targeted at weaker banks and at banks of 'systemically relevant' size, when the state of public finances allowed. Our results encourage theoretical research with respect to non-linear and potentially adverse effects of bailouts, as well as further investigation into the link between the loss absorbing properties of bank capital and loan growth. With respect to bank lending, we find that only large recapitalizations and infusions of common equity are associated with higher total regulatory capital ratios and sustained loan growth. We find no significant relationship between public capital provisions and interbank lending and challenge the view that local banks increase loan growth relatively more in response to a recapitalization.

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1. INTRODUCTION

During the recent financial crisis, a number of governments of mainly developed economies provided substantial economic support to the distressed financial sector. With the aim of stabilizing the flow of credit, they endowed private banks with public resources. In each quarter between 2008Q3 and 2009Q4 these resources amounted to 34–54% of pre-crisis equity for the sample of banks that we analyse in this paper (see Figure 1).

Guided only by the experience of Japan and distinct events such as the rescue of Long-Term Capital Management (LTCM) in 1998, the design of these interventions

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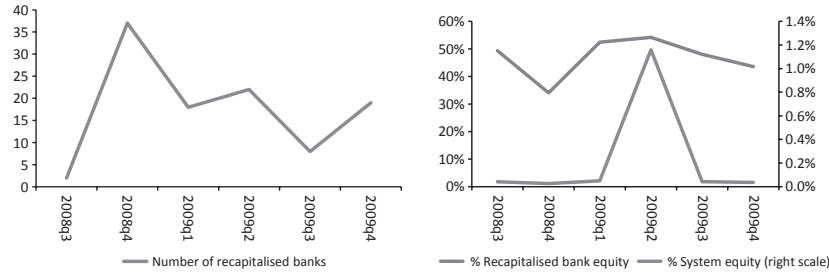

Figure 1. Number of recapitalized banks and relative size of bailouts over time

Notes: The data covers 15 OECD countries (listed in Table 1) that spent at least 2% of their gross domestic product (GDP) on recapitalizations during 2008–9 or had at least three resolved banks reporting to Bankscope. The chart on the right plots the overall size of the interventions over time: first, relative to recapitalized banks' 2006 equity levels (% recapitalized bank equity) and, second, relative to all banks' 2006 equity levels (% system equity).

Source: Data collected from central banks, financial stability authorities and other publicly available sources (for more information see Data Appendix available online), Bankscope.

(bailouts) varied considerably across banks and countries and relied upon often untested theory.[1] Although problematic for policymakers at the time, this variation and the global nature of the events following the rescue of Bear Stearns in March 2008 now provide a unique opportunity for researchers to assess the success of these *ex post* resolution policies. However, whilst the lack of information about effective recapitalizations had been acknowledged in the past, and history strongly suggests that public engagement remains inevitable in the future, the greater part of current research and the regulatory debate continue to be directed predominantly towards crisis prevention rather than crisis resolution.[2]

In contrast, this paper adopts the 'rare event approach' to regulation, that is, the premise that 'financial crises will occur infrequently, but are inescapable', and answers the corresponding call for 'clear-cut provisions for bank bailouts' (Freixas, 2010, p. 378). In other words, we hold the view that governments will continue to be called upon for emergency interventions and we provide guidance on how to employ public resources most effectively in these instances.

Moreover, the information that we provide about effective resolution policies is also valuable for the redesign of global financial regulation in general. Rochet (2010), for example, advances the view that 'the installation of a prompt corrective action regime for the management of crises, including a special resolution regime for systematically important financial institutions' (p. 100) ought to be one of three necessary reforms of

[1] Policymakers and researchers were also able to draw on the experience of the savings and loan (S&L) crisis of the 1980s and 1990s. In contrast to the current period however, the S&L crisis was confined to one country and to a specific type of financial intermediary (thrifts).

[2] Aghion *et al.* (1999) note that 'unfortunately most bank regulations (and in particular the BIS regulations) are concerned with the ex ante problem of how to avoid bank failures, and few rules have been devised on how to deal with bank failures when they occur.' For an extensive summary of recurrent crises, see for example Reinhart and Rogoff (2009).

Table 1. Number and characteristics of recapitalizations by country

Country	Number of sample banks	Recapitalized (%)	Tier1 (%)	/2006 Equity	s.d.	med	Time	Value weighted time
Austria	25	20.0	100	0.690	0.535	0.395	09q2	09q1
Belgium	12	25.0	100	0.507	0.203	0.469	08q4	08q4
Denmark	32	65.6	9.5	0.559	0.498	0.309	09q3	09q2
France	40	12.5	0	0.067	0.018	0.057	08q4	08q4
Germany	23	17.4	100	1.088	0.432	1.214	09q1	09q1
Greece	13	61.5	100	0.379	0.194	0.378	09q2	09q2
Ireland	14	14.3	100	0.488	0.087	0.488	09q1	09q1
Japan	100	4.0	100	0.743	0.513	0.521	09q2	09q2
S. Korea	12	41.7	0	0.090	0.078	0.053	09q1	09q1
Netherlands	28	3.6	100	0.693	0.000	0.693	08q3	08q3
Norway	28	28.6	100	0.433	0.482	0.242	09q4	09q4
Spain	52	1.9	100	1.666	0.000	1.666	09q2	09q2
Sweden	20	5.0	100	0.039	0.000	0.039	09q2	09q2
UK	49	8.2	100	0.565	0.204	0.484	09q1	09q1
USA	100	34.0	100	0.298	0.141	0.278	08q4	08q4

Notes: The table reports the distribution of sample banks across countries as well as average characteristics of recapitalizations. 'Recapitalized (%)' is the percentage of banks per country that was recapitalized between 2008Q3 and 2009Q4. 'Tier1 (%)' is the percentage of recapitalization that involved Tier1 capital. Tier1 capital includes common equity and preference shares. '/2006 Equity' reports the average recapitalization scaled by 2006 bank equity. 's.d.' and 'med' are the corresponding standard deviation and median. 'Time' is the unweighted average timing of recapitalizations rounded to the nearest quarter; 'Value weighted time' is the average timing weighted by the injected amount. The sample includes all countries that spent at least 2% of GDP on recapitalizations between 2008Q3 and 2009Q4 or had at least three resolved banks reporting to Bankscope. The sample excludes bankruptcies and includes nationalized banks that were also recapitalized.
Source: Collected data (see Data Appendix available online), Bankscope.

the regulatory structure (alongside a powerful and independent banking supervisor and simpler prudential regulation). In this context, our results can provide some insight into the nature and the efficient design of these regimes.

Our analysis is in two parts: in the first, we provide an historic account of recent provisions, and examine recapitalizations from 15 OECD economies (see Table 1) in order to identify the main observable pre-crisis (i.e. 2006) characteristics of bailout recipients. In the second part of the paper, we proceed to examine the link between direct public capital injections and bank lending. We are, in line with publicly promoted policy objectives (e.g. Obama, 2009; European Banking Authority (EBA), 2011), particularly interested in identifying the characteristics of bailout schemes that were effective in promoting bank lending.

Our main results are as follows: we find that banks with a higher Tier1 capital ratio (the ratio of preference shares and common equity over total capital) and a larger fraction of liquid assets (government bonds and loans and advances with maturities of less than three months) in 2006 had, during the crisis, a lower probability of being recapitalized; simultaneously, both properties are also found to coincide with smaller sized recapitalizations and with lower risk-absorbing properties of the provided capital. In other words, banks with higher Tier1 capital ratios and more liquid assets were not only less likely to require public support, but also cheaper to bail out.

Moreover, the data exhibits evidence of the 'too big to fail' and the 'too big to save' paradigms: that is, bank liabilities relative to national gross domestic product (GDP) as well as banks' systemically relevant size seem to be positively correlated with the likelihood of receiving public capital; but less so in countries where governments report higher debts and deficits.[3] Finally, we find that recapitalizations of larger banks were more often associated with forced mergers and nationalizations and that, independent of bank size, a shortage of liquid assets is a particularly strong predictor of unconditional recapitalizations.[4]

In addition to documenting the allocation of public resources, our results are also informative with respect to the identification of structural weaknesses and, thus, the design of pre-emptive regulation. In accordance with the current debate, they suggest it is worthwhile to assign a prominent role to capital controls and capital quality as well as to matters of liquidity. In addition, they indicate that such regulation reduces the risk of a crisis (i.e. the probability of the need to be recapitalized) as well as its conditional costs (i.e. the amount of capital provided, and the risk that the government assumes in the process).[5]

In the second part of the paper our analysis suggests that sufficiently large interventions are an effective, albeit potentially expensive, tool for stabilizing banks, and their disposition to lend during crises. Similarly, recapitalizations with common equity (CE), but not with lower tiers of capital are found to be associated with improved lending and larger buffers of regulatory capital (Tier1 and Tier2). Since we show, in Section 4, that banks that receive public capital also had lower solvency and liquidity ratios immediately before the crisis, one can argue that our actually estimated effects of recapitalization on credit supply are potentially biased downwards. Whilst this concern leaves our qualitative results largely intact, it implies that our point estimates should be regarded as lower bounds.

Furthermore, our results challenge the hypotheses that recapitalizations are more effective when provided to locally operating (Cooperative and Savings) banks, and that aggregate capital provisions stabilize the interbank market. Finally, we find the timing of an intervention to be of minor relevance.

In summary, this paper is intended to serve as an empirical reference for current and future theoretical work, but also as an aid to the design of *ex ante* regulatory policies and the efficient design of the aforementioned *ex post* provisions. To this end, we have structured the remainder of our analysis as follows: Section 2 discusses the existing literature and puts our main results into context; Section 3 describes the data, as well as our

[3] In unreported regressions we also find that 'systemically relevant banks' are associated with more costly bailouts, i.e. they seem to have been provided with more capital, and with capital of higher quality. However, less so in countries where public finances are more precarious.

[4] Throughout the paper, we refer to recapitalizations that are not associated with mergers or nationalizations as 'unconditional' recapitalizations. They may still impose conditions, such as, for example, behavioural constraints on the management.

[5] Liquidity shortages have widely been understood as fundamental determinants of the recent financial crisis. For a concise overview see Brunnermeier (2009).

econometric strategies. Section 4 analyses the determinants of recapitalizations and Section 5 identifies the most relevant features of an effective bailout. Section 6 concludes.

2. LITERATURE OVERVIEW

In general, the effect of public recapitalizations on bank lending depends on two main channels.

At the bank level, they relax financing constraints, and, hence, allow the recipients to increase lending, either directly or because of improved collateral value.

The theoretical foundations of this mechanism rely, most prominently, on the work of Holmström and Tirole (1997), but are also reflected in a literature that, motivated by the first Basel accords, examined the role of 'regulatory shocks' to bank equity in the early 1990s. In our understanding, the underlying mechanism is the following: when the value of equity depreciates, leverage increases, as loan portfolios are slow to adjust (Hancock *et al.*, 1995). Therefore, since banks typically target a certain leverage ratio (Adrian and Shin, 2010), and/or have to abide by certain regulatory requirements (Haubrich and Wachtel, 1993; Berger and Udell, 1994; Calem and Rob, 1996; Thakor, 1996), they are forced to cut back on lending as soon as assets become illiquid. Applied to the context of resolution policies, and assuming symmetry with respect to the direction of the shock, this literature would then predict that recapitalizations (i.e. positive 'shocks' to bank equity) increase lending.

Instead, at the aggregate level, the literature has argued that government guarantees (deposit insurance as well as – implicit – bailout guarantees) can serve to prevent credit markets from drying up. This insight goes back to the seminal work of Diamond and Dybvig (1983) and predicts that, if public capital provisions reduce solvency concerns, they should be expected to affect the supply of liquidity indirectly by strengthening, in particular, the interbank market. This rationale underlies not only the recent Recommendation of the European Banking Authority (2011), but also, in general, the capital buffers promoted by the Basel Committee since the late 1980s.

Since the data allows us to identify only a weak increase in interbank lending, we conclude that the first channel is empirically the more relevant one and limit our discussion of the literature to the small, but rapidly growing body of work that is explicitly concerned with the question of optimal bailout design.

In early theoretical contributions to this matter, Diamond (2001) and Diamond & Rajan (2005) highlight the importance of providing sufficient capital, and explain that recapitalizations, which allow banks to write off bad loans but do not permit them to issue new credit, can actually cause bank lending to decrease. Consistent with their predictions, our analysis strongly suggests that loans should only be expected to increase in response to sizeable interventions. Furthermore, we find negative point estimates for the effect of small recapitalizations, and a negative effect on the loans that banks choose to write off their balance sheets (write-offs).

In addition, the literature has also discussed the effects of providing capital with different risk-absorbing properties: Philippon and Schnabl (2010), for example, recommend the provision of stock warrants and preferred stock on the grounds that they mitigate private information rents and opportunistic behaviour and, thus, induce the issuer to carry more risk. In contrast, Wilson (2009) and Wilson and Wu (2010) recommend recapitalizing banks with common equity by arguing that the higher seniority of preference shares requires governments to pay higher subsidies; in fact, they predict provisions of preferred stock to be the least efficient method, as it does not contribute to the stabilization of banks' returns.

Yet, whilst Wilson and Wu's argument resonates well with the emphasis that the EBA assigns to common equity in their definition of Core Tier1 capital, and while the theoretical arguments are plausible, our results appear to reject both theories. On the one hand, our results dismiss the model of Philippon and Schnabl (2010) on the grounds that we find no impact on lending from provisions of preference shares. On the other hand, our results conform to the prediction of Wilson (2009) and Wilson and Wu (2010), but, in contrast with their model, also show that recapitalized banks were, on average, more liquidity constrained. We, therefore conclude that a richer theory of bank recapitalization is needed, and that a deeper understanding of the interaction between the nature of bank capital and lending is required.

In a more recent contribution, Bhattacharya and Nyborg (2011) study equity injections in a private information model, and derive conditions under which they are equivalent to asset buybacks; they emphasize that banks' future investment opportunities can affect the impact of these interventions and, therefore, suggest augmenting asset buybacks with call options. We do not study the issue of combined interventions explicitly, but the relevance of bank-specific investment opportunities addresses an important point; along with, for example, loan demand, they are exemplary of unobservable bank characteristics that may cause point estimates in our analysis to be biased. To account for these concerns, we introduce bank fixed effects and find our coefficients to be robust. So while we cannot exclude the possibility that we have identified a response that is due to *accompanying* policy measures (lending requirements, change of management, etc.), we can reject concerns related to bank specific, but independent, factors.

Our aim is to identify and inform policymakers about the conditionalities of effective bailouts, and in much the same spirit Landier and Ueda (2009) review different options for bank restructuring. They too conclude that due to the diversity of trade-offs, a case-by-case approach is indispensable.

Finally, theoretical considerations that address the long-run costs of bank bailouts include the mitigation of moral hazard through targeted interventions (Fahri and Tirole, forthcoming) as well as risks associated with strict recapitalization policies and distorted management incentives (Aghion *et al.*, 1999). Since the long-term effects on incentives are, in general, not (yet) quantifiable, we leave this particular assessment for future research and restrict ourselves to quantifying the short-run response of bank lending.

Whilst the literature is richer on the empirical front, work on the relationship between recapitalizations and credit typically dates back to the Great Depression, and is confined to specific countries (e.g. Japan) or cases (e.g. LTCM); as a consequence, there is typically less variation in the data. In addition, a few papers have recently emerged in response to the crisis of 2008–10.

Closely related to this paper, Giannetti and Simonov (2011) study the effect of bailouts on loans granted to listed Japanese firms between 1998 and 2004. They find that bailed-out banks extend larger loans but do not encourage the corresponding firms to create significantly more jobs; they also show that low quality firms experience relatively higher abnormal returns as a result of their lenders' bailouts. Since we find that recapitalizations associated with higher loan growth also coincide with increases in non-performing loans, our results seem to be consistent with their findings.

In contrast to Giannetti and Simonov's analysis, however, we do not discriminate between borrowers, and focus instead on the design of the intervention. Hence, whilst we implicitly assume that more credit translates into real economic activity, their work complements this assumption by showing that transmission may be slow or imperfect.

Allen *et al.* (2011) and Montgomery and Shimizutani (2009) also study Japanese data and find that recapitalizations need to be substantial and targeted in order to be effective. In addition, the latter find that providing capital to larger, globally active, banks is more effective. Extending this analysis to our global panel, we are able to confirm both predictions. That is, we identify large and targeted interventions as the most effective and find evidence showing that public capital provided to globally active banks is associated with relatively more lending.

While it has been argued that important lessons can be learned from the experience of Japan (e.g. Hoshi and Kashyap, 2010), it is important to bear in mind that the Japanese crisis, unlike recent events, developed out of a weak real economy.[6] As a consequence, Japanese data is more likely to reflect (often unobservable) loan demand than data from the US and Europe, which, for the most part, slid into recession only after their banking sectors came under pressure. Hence, in order to achieve a more general understanding of bank bailouts, it is useful to explore the novel cross-country dimension of the 2008 crisis and augment the Japanese results with the corresponding insights. This is precisely the contribution of the current paper.

Our approach and data differ importantly from two particular and similar studies. First, Veronesi and Zingales (2010), who identify the risk of bankruptcy as the key friction that had been resolved by US policies, and quantify the corresponding net benefit ($86–$109 billion). They focus on the US, but offer a rich analysis that allows them to touch upon distributive issues and to identify winners and losers of the intervention. In contrast, our paper focuses on average effects, but goes into more detail with respect to the design options for public recapitalizations.

[6] See for example Katz (2009) for a characterization of the differences between the Japanese and the American events.

Secondly, Laeven and Valencia (2011) provide a thorough account of direct fiscal interventions in the financial sector and assess the ultimate impact on firms' growth prospects. In common with our paper, they also exploit the cross-country dimension of data from the recent episode and are, to our knowledge, the only others to study the intensity of recapitalization explicitly. However, in contrast to this paper, they follow Rajan and Zingales (1998) in looking at country aggregates and do not, therefore, disentangle the effects of different bailout features.

In summary, we augment the traditional literature by looking at the relationship between recapitalization and bank lending in a panel data set. As a result, we are able to control for fixed effects that, as we have argued, may have been particularly relevant for the case of Japan. Moreover, we augment the more recent literature on bank bailouts by analysing the effect of public recapitalizations *at the bank level*. The benefit from this degree of disaggregation is that we can look at specific bank and bailout characteristics in order to inform future policies and to derive lessons for the many conditionalities that the theoretical literature has proposed.

3. DATA

3.1. Sample

As mentioned in the preceding section, the novelty of our analysis depends to a large extent on the fact that we have information about direct public recapitalizations at the individual bank level. This information has been collected from public sources such as central banks and financial stability authorities (see Data Appendix available online for more detail); in addition to bank identifiers, the data includes detail on the dates (year and quarter) and sizes of the bailouts as well as the risk-absorbing properties of the provided capital. In principle this data is available at quarterly frequency for the period 2008Q3 to 2009Q4; however, in order to be able to match the sample with balance sheet information from the *Bankscope* database, we aggregate it to annual frequency.

We have collected information on a total of 548 banks, from 15 OECD countries, that report consolidated (C1 & C2) information to *Bankscope*; 19.34% (106) of these banks were publicly recapitalized and we require that countries have either spent at least 2% of GDP on direct public recapitalizations or have at least three resolved banks reporting to *Bankscope* (Table 1). Furthermore, in the case where too many institutions per country report to *Bankscope*, we restrict attention to the 100 largest banks in order to maintain a sufficiently balanced sample (this restriction applies specifically to the US and Japan).

Unfortunately, not all of the banks report all variables of interest at all times, leading us to restrict the sample to 392 banks in the first part of our analysis and, in the second part, to 500 banks that report lending activity in the benchmark regression. Some of these banks report data for only one or two years in the period 2008–10.

Because in our sample there are no recapitalizations before 2008 and our focus is on the effect of public interventions during times of financial turmoil, we generally restrict our attention to the three years 2008–10 (i.e. to 1,387 bank-year observations in the benchmark regression of Section 5); generally, however, balance sheet data is also available for periods prior to 2008, and we use observations for 2006 to pin down the values for 'pre-crisis characteristics' in Section 4; data for 2007 to calculate credit growth between 2007 and 2008; and observations for 2004–7 to estimate our baseline regression on a placebo sample in Section 5.

Unless stated otherwise, our definition of recapitalization is narrow and excludes instances in which banks were either forced into mergers or nationalizations. However, we also have information on these other forms of bailouts and analyse them in Section 4. We also eliminate cases of bankruptcy in order to avoid distortions. Since none of the bankrupt institutions received a public capital injection prior to failure, this simplification increases average loan growth in the group of non-recapitalized banks; hence, even if the exclusion were to be a source of bias, it would lead us to underestimate the effect of a public recapitalization.

As indicated in the introduction, there is considerable variation in the way in which recapitalizations were conducted; even with respect to country averages (see Table 1). For example, even though Germany and France recapitalized a similar number of banks, Germany has provided capital that amounts to roughly the size of banks' pre-crisis equity, while France has provided only about 7% (column 5); and while Germany provided capital only in the form of common equity, France provided only lower tiers (column 4).

We attribute this variation to considerable academic uncertainty, as fundamental determinants have not yet been widely studied. One recent exception, however, is the work of Nier *et al.* (2011), who provide a systematic assessment of institutional models and report, among other things, that countries where the central bank and the financial regulator are a single institution, tend to provide, on average, lower recapitalizations. This finding is, to some extent, reflected in our sample: for example, Korea and Norway have their respective financial supervisor integrated into the central bank, while the same is not true in Spain or the Netherlands. However, cases such as the US or Greece, which both have independent financial supervisory authorities, provide evidence that deeper, structural problems are equally important.

Another reason why recapitalization values are relatively low, for example for the UK and Spain, is that they make more frequent use of forced mergers.[7]

[7] The numbers of forced mergers in the UK and in Spain are equal to 32 and 7 respectively. Nationalizations and bankruptcies were less frequent and more evenly distributed across countries. In our original sample of 548 banks we counted 106 recapitalizations, 27 nationalizations, 47 forced mergers, and 10 bankruptcies.

3.2. Key variables

The two key variables are 'recapitalization' and 'loan growth' and, for robustness and additional insight, we analyse several variations of both. 'Recapitalization' in the first part of our analysis (Section 4) will be the left-hand side variable that is explained by banks' pre-crisis (i.e. 2006) characteristics, whilst in the second part of the analysis (Section 5) it is considered to be the main right-hand side variable explaining 'loan growth'. 'Loan growth' only enters as a left-hand side variable in Section 5.

When 'recapitalization' is measured as a continuous variable, it is equal to the amount of public capital that a bank had received during 2008–10, scaled by 2006 equity.[8] Since we had only 14 banks in our sample receiving multiple injections, we use the aggregate received over 2008–10 and time the injection at the average value weighted time of all received injections rounded to the nearest year. The value of the variable is equal to zero prior to and equal to the aggregate amount for all dates, after this date.

When recapitalization is measured as a dummy variable, it is equal to one for the year of recapitalization and all years after the intervention, and zero otherwise. For example, the 'recapitalization' dummy for a bank that received a recapitalization in 2009 will be equal to zero in 2008 and equal to one during 2009–10, accounting for the lasting effect of a public intervention.

Furthermore, we analyse dummy variables for specific types of interventions. That is, for interventions of different size brackets (High, Medium, Low) or with different types of capital (CE, Tier1). As before, the corresponding dummy variables are equal to one during and after the year in which a provision of a specific type is received and zero otherwise.

The main dependent variable in Section 5 is the year-to-year change in the ratio of loans to assets, that is, in the *propensity to lend* (PTL), which we formally define as:

$$\Delta PTL_{i,t} \equiv \frac{L_{i,t}}{A_{i,t}} - \frac{L_{i,t-1}}{A_{i,t-1}}$$

with $L_{i,t}$ being the accounting value of total loans held by bank i at date t and $A_{i,t}$ being the corresponding value of total assets.[9]

Scaling by time-varying asset values allows us to identify changes of bank lending *conditional on available resources*, as opposed to differences in lending that may result simply from (exogenous) shocks to the size of the balance sheet. Moreover, this specification also allows us to identify positive cases in which absolute lending decreased

[8] For robustness, we also scale by total regulatory capital (Tier1 and Tier2) in 2006 and by risk-weighted assets in 2006.

[9] Note that if we say that we observe changes in *PTL* for 2008–10, this implies that values for 2007 are taken into account when we define values for $\Delta PTL_{i,2008} = (L_{i,2008}/\ A_{i,2008}) - (L_{i,2007}/\ A_{i,2007})$. Loan growth between year 2007 and 2008 is expressed as a function of recapitalization in year 2008. There are no recapitalizations in our sample in 2007.

due to external factors, but in which the public intervention served to stabilize, that is, to mitigate the drop in the provision of loans.

An alternative way of accounting for the influence of movements in balance sheet size is to define the absolute change in loans as the dependent variable, that is, to define:

$$\Delta L_{i,t} \equiv \mathrm{In}\left(\frac{L_{i,t}}{L_{i,t-1}}\right)$$

and to account for the change in asset value through additional controls. We add this alternative regression as a robustness exercise and find no significant difference in the results. This is because scaling by asset levels effectively fulfils the same purpose as controlling for asset growth; our results on changes in *PTL* can, therefore, be interpreted as capturing the effect on total loan growth conditional on asset growth.

Further variations of our benchmark analysis consist in looking at the effect on regulatory capital levels, on non-performing loans and on loans that banks choose to write off. Finally, we introduce country aggregates and measures of interbank lending to assess the 'systemic' impact of recapitalizations.

In preparation of our econometric analysis, Table 2 provides descriptive statistics for our key variables: the figures show, for example, that average recapitalizations (across all years and countries) amounted to 45% of (recapitalized banks') pre-crisis equity levels (or 42% of 2006 regulatory, i.e. Tier 1 and Tier 2, capital and 5% of 2006 risk-weighted assets), but, with a standard deviation of 0.41, also that there is considerable variation across banks and years.

These statistics are also informative with respect to the different categorizations of recapitalization size and the risk absorbing properties of the capital provisions. Whilst 'High' recapitalizations (i.e. those above the 75th percentile) accounted, on average, for 101% of pre-crisis equity levels and varied considerably (s.d. = 0.46), it seems to be the case that 'Low' recapitalizations (i.e. those below the 25th percentile) amounted to only about 12% of pre-crisis equity and were also less volatile (s.d. = 0.06).

Interestingly, the figures also show that provisions of common equity were on average smaller than capital provisions in general (rows 6 and 7). Hence, when we find that both large recapitalizations and recapitalizations with common equity are most effective, the evidence in Table 2 suggests that these effects are indeed distinct. That is, the effects of CE provisions are not driven, for example, by the fact that these interventions are also larger.

Finally, Table 2 provides interesting insights with respect to the different measures of loan growth. It suggests, for example, that interbank loan (IBL) growth and the growth of non-performing loans (NPL) are statistically identical in the subgroups of recapitalized and non-recapitalized banks, while loan growth in general (relative to assets and in absolute terms) seems to be significantly lower in

Table 2. Summary statistics of key variables used in the estimation

	Mean full sample	s.d. full sample	Mean non-recapitalized banks (1)	Mean recapitalized banks (2)	s.d. recapitalized banks	Test (1)=(2) *p*-value
Recapitalization (/2006 Equity)	0.09	0.25	0.00	0.45	0.41	
Others recapitalization	0.12	0.11	0.11	0.15	0.09	
High recap	0.05	0.24	0.00	1.01	0.46	
Medium recap	0.02	0.09	0.00	0.40	0.05	
Low recap	0.01	0.03	0.00	0.12	0.06	
Common equity (CE) recap	0.03	0.17	0.00	0.74	0.55	
Tier1 recap	0.07	0.23	0.00	0.38	0.43	
Early recap size	0.04	0.18	0.00	0.41	0.40	
Late recap size	0.04	0.19	0.00	0.49	0.42	
Local bank recap size	0.02	0.14	0.00	0.48	0.51	
Global bank recap size	0.07	0.22	0.00	0.43	0.38	
Dependent variables (2008–10)						
$(L_t/A_t) - (L_{t-1}/A_{t-1})$	0.00	0.05	0.00	−0.01	0.05	0.05
$(IBL_t/A_t) - (IBL_{t-1}/A_{t-1})$	0.00	0.06	0.00	0.00	0.04	0.36
$\ln(L_t/L_{t-1})$	0.08	0.25	0.09	0.01	0.18	0.00
$(NPL_t/L_t) - (NPL_{t-1}/L_{t-1})$	0.91	3.47	0.93	0.83	0.36	0.72
$(WO_t/L_t) - (WO_{t-1}/L_{t-1})$	1.21	2.04	1.03	2.04	2.07	0.00

Notes: 'Recapitalization' is the aggregate amount of capital received by a specific bank, scaled by this bank's 2006 equity level. 'Others recapitalization' is the aggregate amount of capital received by all other banks in the same country scaled by aggregate 2006 equity. 'High recap' includes all 'Recapitalizations' above the 75th percentile, 'Medium recap' refers to those between the 25th and 75th percentile and 'Low recap' includes all capital injections in the 25th percentile. 'CE recap' refers to all 'Recapitalizations' that were conducted with common equity; 'Tier1 recap' refers to all 'Recapitalizations' that provided the bank with Tier1 capital. L_t are gross loans, including all household and corporate loans. IBL_t are interbank loans, i.e. loans and advances to other banks. Non-performing loans (NPL_t) include overdue loans and restructured loans. Write-offs (WO) are loans that banks choose to write off their balance sheets, scaled by gross loans. The last column is the two-tailed p-value of a t-test allowing for differences in variance between the recapitalized and non-recapitalized banks. Summary statistics for control variables are provided in the Appendix.
Source: Collected data (see Data Appendix available online), Bankscope.

the subsample of recapitalized banks. In line with the predictions of Diamond (2001), write-offs, instead, seem to be significantly higher among banks that were publicly bailed out.

While, the last facts in particular may constitute a challenge to the common trend assumption of the Propensity Score Matching (PSM) model that we will outline in the next section, they also suggest that the corresponding bias would lead us to *under*estimate the actual effect on loan growth.

3.3. Econometric models

3.3.1. Determinants of recapitalization. In Section 4 we identify determinants of recapitalization, estimating standard Probit, Ordered Probit and Tobit models. The dependent variables are variations of the aforementioned 'recapitalization' variable: equal to the recapitalization dummy for the Probit and equal to the accumulated value of received capital provisions for the Tobit model. Instead, for the Ordered Probit model, the dependent variable takes higher values for capital with better risk-absorbing properties. More precisely: it is equal to zero for cases without capital injection; equal to one for subordinated debt; two for preference shares; and equal to three for common equity. The list of regressors includes bank characteristics evaluated at 2006 levels, that is, prior to the crisis as well as variables capturing the banks' systemic relevance and country fixed effects. More precisely, these variables account, for example, for banks' pre-crisis levels of liquid assets, Tier 1 capital, the ratio of loans over deposits or loan loss provisions. In addition, banks' systemic relevance is captured by the ratio of their liabilities to national GDP.

For robustness, we also estimate a Cox semi-parametric proportional hazard model for the time to recapitalization (measured in quarters from 2007Q1); the dependent variable there is the quarterly probability of recapitalization, that is, the hazard function of time until recapitalization starting from 2007. The regressors are identical to the ones used in the aforementioned Probit and Tobit models.

3.3.2. Effect on credit growth. In Section 5, we exploit the panel dimension of the data and estimate changes in loan growth as functions of different recapitalization measures, using the following benchmark specification:

$$\Delta PTL_{i,t} \equiv \alpha + \beta R_{i,t} + \gamma \ln(A_{i,t}) + \sum_{s} \delta_s B_{i,s} + \sum_{v} \phi_v C_{i,v} + \sum_{T} \varphi_T \Upsilon_{t,T} + u_{i,t}$$

In addition to the two key variables, that is, the change in *PTL* or 'loan growth' and the time-varying recapitalization measure, the model includes a measure of bank size, $\ln(A_{i,t})$, where A is total assets, and a set of dummy variables for the specialization of the bank, $B_{i,s}$, with s = {Investment bank, Cooperative bank, Real estate bank, Savings bank}. We also include country (C) and year (Υ) fixed effects and cluster the standard errors at the country level. In addition, our robustness analysis includes specifications with country*year and bank fixed effects, and substituting $\Delta PTL_{i,t}$ by absolute loan growth[10] as well as estimating our model for a placebo period.

Moreover, we provide robustness analyses for a different scaling of the recapitalization variable; that is, in addition to the benchmark of scaling by 2006 equity levels, we also scale it by 2006 total regulatory capital or by 2006 risk-weighted assets.

[10] $\ln(L_t / L_{t-1})$ where L_t is gross loans at time t, and adding $\ln(A_{i,t})$ as an additional control.

Furthermore, we also estimate a Propensity Score Matching model (PSM) using the Nearest Neighbour Method (NNM) to match single units with replacements and provide estimated treatment effects.[11] The point estimates of this model essentially amount to comparing loan growth of recapitalized and non-recapitalized banks before and after recapitalization. The peculiarity of the model is that banks are matched according to observable factors, implying that the comparison is conducted among banks that resemble each other.

In the next section, we show that banks that received public injections had on average lower solvency and liquidity ratios; suggesting that banks for which it is more difficult to achieve access to capital and funding are likely to show greater reluctance to extend credit in the crisis. This implies that the ordinary least squares estimates of β we report in the later part of the paper are potentially biased downwards.

4. RESULTS: DETERMINANTS OF RECAPITALIZATIONS

Table 3 is based on Probit, Tobit and Ordered Probit models and provides our initial results. It identifies the pre-crisis characteristics of banks that are associated with high probabilities of receiving public capital (column 1), and, conditional upon them receiving support, related to more extensive interventions (column 2). In column (3) the analysis is augmented to explore how the same characteristics relate to the provision of capital with better risk-absorbing qualities.

As mentioned before, pre-crisis variables are in 2006 values and the dependent variable is a measure of 'recapitalization'; in column (1), the dependent variable is a 'recapitalization' dummy. In column (2), 'recapitalization' includes the aggregate amount of received capital per bank, scaled by pre-crisis equity levels, and in column (3), higher values of the dependent variable are associated with better risk-absorbing properties. Since some banks do not report all variables at all dates, the sample contains 392 or 375 banks, depending on the control variables that we include.

In addition to the determinants of public bailouts, we also report ratios of 'prediction accuracy', and define a prediction to be correct if the predicted probability of being recapitalized exceeds the sample probability and the bank has in fact been recapitalized. The value 80.52 in column (1) then implies that our model correctly predicts 80.52% of the recapitalizations.

Across all specifications, the evidence shows that higher Tier 1 capital ratios and higher levels of liquid assets correspond to lower probabilities of being recapitalized and, conditional upon the reception of public support, to lower risk-absorbing qualities and lower levels of injected capital.

Moreover, the results in Table 3 and Table 4 jointly provide evidence of the 'too big to fail' paradigm, that is, of the fact that large banks are more likely to be bailed

[11] See Dehejia and Wahba (2002) for an assessment of the NNM with replacement.

Table 3. Determinants of recapitalization (benchmark)

	(1) Probit	(2) Tobit	(3) Ordered Probit
Tier1 Capital	−0.017***	−0.056***	−0.111***
	(0.003)	(0.012)	[0.027]
Liquidity	−0.535***	−1.614***	−2.938***
	(0.148)	(0.310)	[0.713]
Loan/Deposits	−0.002	−0.004	−0.007
	(0.005)	(0.003)	[0.010]
Provisions	−3.163	6.006	−42.16
	(8.824)	(14.355)	[53.598]
Non-performing loans	1.152	3.933*	10.367
	(1.171)	(2.148)	[7.128]
Ln(total assets)	3.041**	6.695***	13.984**
	(1.257)	(2.528)	[5.544]
Investment banks	0.150	0.437	0.548
	(0.243)	(0.314)	[0.833]
Cooperative banks	0.044	0.098	0.063
	(0.088)	(0.157)	[0.398]
Real estate banks	−0.104***	−0.565**	−1.064***
	(0.018)	(0.246)	[0.362]
Savings banks	−0.008	0.000	0.723
	(0.109)	(0.180)	[0.679]
% Recapitalized	19.64		
% Recapitalized correct	80.52		
% Non-recapitalized correct	75.63		
Country FE	yes	yes	yes
Number of banks	392	392	392
Pseudo *R*-squared	0.28	0.24	0.39

Notes: Standard errors clustered by country in parentheses.

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. Column (1) reports marginal effects for the Probit model of the effect of 2006 bank characteristics on the probability of recapitalization. See Table A1 in the Appendix for definitions of the explanatory variables.

out *because of their systemic relevance*. In Table 3 the natural logarithm of total assets, that is, of banks' balance sheet size, acts as a proxy for this effect; instead, in Table 4 it is suggested that the relevant underlying factors are the amount of banks' liabilities relative to national GDP. In addition, the numbers seem to suggest that the 'too big to fail' principle applies to a lesser degree in countries with a high debt to GDP ratio; that is, in countries that are less able to finance any given recapitalization measure and where these banks are simply 'too big to save'. These results are robust to defining the threshold for 'systemic relevance' as a ratio of bank liabilities over GDP equal to 5% (Table 4, column 2), 10% (column 3) or 25% (column 4).

For additional clarity on the economic size of the effects, we report predicted probabilities in Table 5. They imply, for example, that the effect of being endowed with Tier1 capital over and above the 75th percentile of our sample distribution, rather than below the 25th percentile, reduces the probability of being recapitalized by almost seven percentage points (from 26% to 19.1%). Similarly, being endowed with

Table 4. Determinants of recapitalization (robustness analysis)

	(1)	(2)	(3)	(4)
	Probit			
Tier1 Capital	−0.017***	−0.016***	−0.020***	−0.021***
	(0.003)	(0.003)	(0.003)	(0.004)
Liquidity	−0.390**	−0.422**	−0.443***	−0.464***
	(0.156)	(0.173)	(0.168)	(0.154)
Loan/Deposits	−0.006	−0.006	−0.005	−0.007**
	(0.004)	(0.003)	(0.003)	(0.003)
Provisions	−2.869	−4.941	−4.903	−2.763
	(7.954)	(8.068)	(8.954)	(5.766)
Non-performing loans	1.283	0.778	0.889	1.120
	(1.090)	(1.013)	(1.110)	(1.035)
Ln(total assets)	2.504*	2.959	1.113	−0.441
	(1.281)	(2.424)	(0.914)	(1.515)
Investment banks	0.166	0.251	0.308*	0.420***
	(0.187)	(0.201)	(0.178)	(0.148)
Cooperative banks	0.057	−0.008	−0.038	−0.014
	(0.090)	(0.110)	(0.090)	(0.103)
Real estate banks	−0.100***	−0.076***	−0.060	0.038
	(0.018)	(0.017)	(0.042)	(0.133)
Savings banks	0.002	−0.024	−0.045	−0.015
	(0.109)	(0.086)	(0.069)	(0.068)
Return on assets	0.028	0.014	0.030	0.032
	(0.025)	(0.014)	(0.024)	(0.022)
Long term funding	0.002	0.002	0.002	0.003*
	(0.002)	(0.002)	(0.002)	(0.002)
Non-deposit funding	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Systemic bank dummy (SD)		0.274	0.392***	0.801***
		(0.278)	(0.082)	(0.148)
(Debt/ GDP) × SD		−0.004**	−0.002***	−0.002***
		(0.002)	(0.001)	(0.001)
(Budget deficit/ GDP) × SD		−0.041**	−0.032**	−0.038***
		(0.018)	(0.013)	(0.013)
Country FE	Yes	Yes	Yes	Yes
Number of banks	383	375	375	375
Pseudo R-squared	0.29	0.33	0.34	0.37

Notes: Standard errors clustered by country in parentheses.

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. Marginal effects are reported. See Table A1 for a definition of all explanatory variables. 'SD' is a dummy variable equal to one if Liabilities/ GDP > 0.05 in column (2); if Liabilities/ GDP > 0.10 in column (3) and if Liabilities/ GDP > 0.25 in column (4).

Table 5. Predicted probabilities of being recapitalized

	25th percentile	50th percentile	75th percentile
Tier1	0.260	0.230	0.191
Liquidity	0.257	0.236	0.184
log(assets)	0.156	0.189	0.234

Notes: Results based on the Probit model in Table 3, column (1).

liquid assets below the bottom as opposed to above the top 25th percentile is associated with an almost eight percentage point higher probability of being recapitalized.

As mentioned in the introduction, we believe that these observations are not only relevant from a historical perspective, but also contribute to the debate on pre-emptive regulation: the estimates suggest, for example, that banks should be required to hold significantly higher levels of Tier 1 capital. More specifically, they indicate that this would serve not only to reduce the likelihood of a bank requiring a bailout, but also to limit the potential capital and risk transfer from and to the government, and, thus, to reduce the conditional cost of such an intervention.

The results also show that it is important to address the issue of maturity mismatch in order to reduce the probability and the cost of recapitalizations: for example, increasing the fraction of liquid over total assets from 0.5% (sample minimum) to 8.7% (sample median) reduces the value of the received recapitalization by 0.5 s.d.; in joint consideration with the fact that many banks appeared to be in compliance with regulatory capital requirements before the crisis (Demirgüç-Kunt *et al.*, 2010) the analysis, therefore, urges practitioners and regulators alike to pay close attention to the risks related to asset (il)liquidity.

Finally, our findings identify the banks' systemic size as an important predictor of recapitalizations, and as a significant determinant of the amount, as well as the risk-absorbing qualities, of injected capital. Our results, therefore, provide empirical support in favour of the common conjecture that large financial institutions are more likely to be provided for by the government, and indicate that the conditional costs and the risk transfer are higher when governments are forced to bail these institutions out.

In Table A4 in the Appendix we obtain similar results using a proportional hazard model where the dependent variable is the quarterly probability of recapitalization, that is, the hazard function of time until recapitalization starting from 2007. In this model, a one percentage point increase in Tier 1 capital is, for example, associated with a 11% (1 – exp(–0.114)) lower hazard rate (i.e. probability of recapitalization in year t); in response to a one percentage point increase in the liquidity ratio, the rate is 9.6% ((1 – exp(–3.5))/100) lower. The results, as in Table 4, are again robust to the different thresholds that we use for defining a systemically important bank.

Next, we also examine whether the identified characteristics contain different explanatory powers for different resolution policies. More specifically, we analyse whether they relate differently to interventions that entail either a (forced) merger or a nationalization. To arrive at the corresponding results, we estimate a multinomial logit model, using dummy variables to identify direct recapitalizations, forced mergers and nationalizations. The set of control variables is identical to the baseline specification used in Table 3.[12]

[12] We were not able to run this regression with the additional set of controls because many of the banks which were nationalized or forced into mergers did not report information on funding structure and funding maturity.

Table 6. Different forms of bank resolution (multinomial logit)

	Recapitalized	Merged	Nationalized
Tier1 Capital	−0.189***	−0.418**	−0.514*
	(0.058)	(0.191)	(0.306)
Liquidity	−6.868***	−1.046	−1.710
	(2.579)	(2.258)	(3.746)
Loan/Deposits	−0.132	−0.0576	0.001
	(0.141)	(0.146)	(0.033)
Provisions	−27.072	−35.053	156.215
	(80.203)	(207.322)	(258.552)
Non-performing loans	12.238	−10.531	−0.780
	(13.715)	(40.555)	(28.316)
Ln(total assets)	12.723	47.233**	90.000***
	(13.646)	(22.085)	(32.797)
Investment banks	3.330**	−15.213	−15.548
	(1.590)	(6788.231)	(8665.626)
Cooperative banks	0.331	0.964	−15.412
	(1.170)	(1.416)	(3566.288)
Real estate banks	1.539	1.544	−15.184
	(1.177)	(1.169)	(2046.115)
Savings banks	−0.181	3.573***	0.625
	(0.779)	(0.848)	(1.581)
Country FE	Yes	Yes	Yes
Number of observations	392		
Pseudo *R*-squared	0.46		

Notes: Standard errors in parentheses.

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. This table reports multinomial logit estimates, differentiating between different forms of bank resolution: recapitalization, forced merger and nationalization. Bankruptcies are excluded due to an insufficient number of cases. The control group includes only healthy banks, i.e. banks that were not resolved. See Table A1 for a definition of all explanatory variables.

The findings we present in Table 6 suggest that unconditional recapitalizations were more often allocated to banks with low pre-crisis levels of liquid assets and Tier 1 capital; moreover, while low levels of Tier 1 capital are similarly strong predictors of nationalizations and mergers, it also seems to be the case that these policies were more frequently applied to larger banks.

In conclusion, our findings give support to the view that ensuring liquidity during times of systemic distress (either by requiring banks to hold more liquid assets or by installing institutional emergency facilities) is useful for reducing public costs. Furthermore, our findings are favourable towards discussions that aim at restricting the emergence of institutions that are 'too big', as these banks appear to be more likely, not only to 'fail', but also to require more costly restructuring.

5. RESULTS: RECAPITALIZATION AND LENDING

Given that the crisis of 2008 took both academics and practitioners by surprise, and that the subsequent interventions were subject to tight time and information constraints, it is advisable to ask whether those interventions were in fact successful, and if

so to analyse how the efficiency of these measures could have been improved. Exemplary for the vast majority of recapitalization schemes, the terms and conditions of the US Treasury's Capital Assistance Program serve to summarize the most common objectives of these interventions. They require that participants:[13]

1. will be subject to the executive compensation requirements in line with the Emergency Economic Stabilization Act of 2008, […].
2. must submit a plan for how they intend to use this capital to preserve and strengthen their lending capacity […]
3. will be required to submit to Treasury monthly reports on their lending broken out by category
4. will […] be subject to restrictions on paying quarterly common stock dividends, repurchasing shares, and pursuing cash acquisitions.

Hence, in addition to enforcing behavioural conditions (1) and transparency (3), recapitalization schemes were, in particular, intended to improve lending capacities (2), and to control the allocation of revenues amongst creditors (4). (1) and (3) are tools to achieve compliance with (2) and (4), and while the question of allocating the burden of the crisis among creditors is an interesting one, our focus is on studying the success of governments in promoting lending through direct recapitalizations.[14]

We are the first to acknowledge that there are other means of public recapitalization (e.g. conversion of debt to equity, implicit and explicit guarantees) and that, in some cases, there are objectives other than the expansion of credit associated with them (e.g. financial stability, omission of default or contagion). We incorporate these elements, to some extent, in Section 5.2 and in the Appendix (Table A5) where we look at the effects on interbank lending, regulatory capital and non-performing loans. However, for clarity and due to data limitations, we constrain ourselves to the identification of the effect of one particular form of recapitalization (direct) on one particular outcome variable (credit growth).

5.1. 'Bailout' characteristics

5.1.1. Benchmark and recapitalization size. Our benchmark results are presented in Table 7: column (1) corresponds to the benchmark model, whereas in column (2), 'recapitalization' is measured as a time-varying dummy variable (equal to zero prior to the intervention, equal to one for all periods after the intervention).

[13] Source: http://www.financialstability.gov/roadtostability/capitalassistance.html; the Capital Assistance Program was launched on 25 February 2009.

[14] See the aforementioned study by Veronesi and Zingales (2010) for an analysis of burden sharing. Wilson (2009) poignantly motivates his concern with public recapitalizations by arguing that 'the government's primary mechanism for improving the troubled bank's lending decision is recapitalizing the bank' (p. 4).

Table 7. Baseline effect of recapitalization on relative loan growth (OLS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				Absolute loan growth			Placebo (2004–2007)		
Recapitalization	0.011**								
	(0.005)								
Recap dummy		−0.001							
		(0.004)							
High recap dummy			0.021***	0.022**	0.021**	0.037**	−0.009***	0.018**	0.012*
			(0.007)	(0.008)	(0.010)	(0.016)	(0.003)	(0.007)	(0.006)
Med recap dummy			0.001	0.002	0.001	0.006	0.003	−0.005	−0.001
			(0.005)	(0.005)	(0.014)	(0.011)	(0.004)	(0.005)	(0.005)
Low recap dummy			−0.008	−0.008	−0.023	−0.008	0.000	−0.007	0.003
			(0.006)	(0.005)	(0.017)	(0.020)	(0.004)	(0.007)	(0.007)
Country FE	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Country ×Year FE	No	No	No	Yes	No	No	No	No	No
Bank FE	No	No	No	No	Yes	No	No	No	No
Number of observations	1387	1387	1387	1387	1387	1384	1393	1357	1085
R-squared	0.06	0.06	0.07	0.16	0.04	0.41	0.10	0.06	0.07

Notes: Standard errors are clustered by countries and reported in parentheses.

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. In columns (1)–(5) and (8)–(9), the dependent variable is the year-to-year change in the loan to assets ratio. In column (1), recapitalization is a continuous variable equal to the aggregate cumulative amount of public capital received (scaled by initial 2006 equity). In column (2), it is a dummy variable equal to one after the bank is recapitalized. In columns (3) to (9) the group of recapitalized banks is split into three sub-groups: High recap' includes all 'Recapitalizations' above the 75th percentile, 'Med recap' refers to those between the 25th and 75th percentile and 'Low recap' includes all capital injections in the 25th percentile. Percentiles are calculated for distributions of recapitalization over 2006 levels of bank equity (columns 3–5), of recapitalization over 2006 levels of regulatory capital (column 8) or of recapitalization over 2006 levels of risk-weighted assets (column 9).

We find that a one standard deviation increase in the size of the injection is associated with 9% of a standard deviation increase in credit growth ([0.011*0.41/0.05]* 100 = 9.02) while there appears to be no significant effect related to the average event of a recapitalization (column 2). We acknowledge that these estimates are likely to be biased downwards as we have seen that on average public injections are targeted to weaker banks. If the interventions are split into categories of 'High', 'Medium' and 'Low' according to their relative position in the sample distribution, columns (3)–(5) reveal a robust and positive coefficient, linking 'High' public capital injections to higher credit growth. In contrast, the point estimates for small and medium-sized interventions are insignificant and potentially negative, as predicted, for example, in the work of Diamond (2001). 'High' recapitalizations are defined to include provisions above the 75th percentile, which, in our sample, corresponds to the range between 49.22% and 166.62% of pre-crisis equity (the mean injection for this subsample is 101.40%, the corresponding s.d. is 49.22%). 'Medium' sized interventions cover the range between the 75th and the 25th percentile (48.95% to 31.59%) and 'Small' interventions are those below the 25th percentile (20.70% to 2.42%).

The point estimates are robust to estimating the regression with country and year dummies (column 3), with country*year fixed effects (column 4) to control for demand effects at the national level, or with bank and year fixed effects (column 5). The positive and significant coefficient is also robust to estimating an alternative specification with absolute loan growth, that is, with $\ln(L_{i,t}/L_{i,t-1})$, as the dependent variable, and lagged assets, that is, $\ln(A_{i,t-1})$, as additional control (column 6). Defining the dummy variables on distributions of recapitalization over 2006 regulatory capital levels (column 8) or over 2006 risk-weighted assets (RWA, column 9) also leaves the result unaffected.[15] To exclude the possibility that our results are driven by systematic differences between the subsamples of recapitalized and non-recapitalized banks, we also provide a placebo regression for the period 2004–7, hypothesizing that all public interventions occurred three years earlier (column 7). Consistent with our expectation, we find no favourable effect in this sample; if anything, we find that banks in the sample of recapitalized banks experience marginally *lower* credit growth and, thus, that the coefficients would be biased against our result.

Clearly, from a welfare perspective, the desirability of large capital injections also depends on the political and economic costs of an intervention. Since we do not account for these factors in our analysis, our results should not be interpreted as an unconditional proposal in favour of large public recapitalizations. However, our evidence seems to be generally inconsistent with rationale that predicts higher credit growth in response to smaller interventions (i.e. those that amount to less than

[15] The definition of 'High' recapitalizations in columns (8) and (9) is different from the benchmark case. On average, 'High' recapitalizations correspond to 91.77% of pre-crisis regulatory capital in column (8), and to 12.12% of pre-crisis RWA in column (9). Furthermore, 'High' recapitalizations range between 37.33% and 210.67% (s.d. = 57.69%) of pre-crisis regulatory capital or between 4.70% and 25.07% (s.d. = 8.30%) of pre-crisis RWA.

49.22% of banks' pre-crisis equity, less than 37.33% of pre-crisis regulatory capital or less than 4.70% of pre-crisis RWA), leading us to conclude that recapitalizations in this range are generally, and independent of their costs, not to be recommended.

5.1.2. Loss-absorbing properties. When it comes to the design of public interventions, policymakers decide not only on the size but also on the associated risk transfer, that is, on the quality of the capital they choose to provide. Motivated by the theoretical work cited in Section 2 (Wilson, 2009; Philippon and Schnabl, 2010), we therefore proceed to the study of the relationship between provisions of common equity and bank lending. In comparison with other forms of Tier 1 capital (e.g. preference shares), common equity is typically associated with a more risky lender position, as it does not generally imply a promise of fixed payments. However, the theoretical implications of this feature are unclear and have been predicted to imply both a reduction of private rents (Philippon and Schnabl, 2010) and lower costs of efficient lending (Wilson, 2009), and thus a relative advantage and a relative disadvantage in its ability to promote bank lending.

In order to assess these different theories, we repeat the benchmark analysis, but introduce a dummy variable for capital injections that have been conducted with common equity. Ideally we would like to combine the analysis with considerations related to recapitalization size, that is, look at small common equity provision as opposed to large common equity provisions; however, our sample is not sufficiently deep to allow for such detail. Yet, as previously mentioned, the summary statistics (Table 2) reveal that common equity provisions are typically smaller than average recapitalizations and, thus, suggest that any effect we find is unrelated to the size of the intervention and, instead, related to its risk-absorbing properties.

Table 8. Effect of recapitalizations with common equity on relative loan growth

	(1)	(2)	(3)	(4)	(5)	(6)
CE recap dummy	0.024***	0.030***	0.020***	0.026***	0.034**	0.043**
	(0.007)	(0.007)	(0.006)	(0.007)	(0.014)	(0.017)
Tier1 recap dummy		−0.007*		−0.006*		−0.010
		(0.004)		(0.003)		(0.010)
Country FE	Yes	Yes	No	No	No	No
Year FE	Yes	Yes	No	No	Yes	Yes
Country × Year FE	No	No	Yes	Yes	No	No
Bank FE	No	No	No	No	Yes	Yes
Number of observations	1387	1387	1387	1387	1387	1387
R-squared	0.07	0.07	0.15	0.16	0.04	0.04

Notes: Standard errors clustered by country in parentheses.

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. The dependent variable is the year-to-year change in the loan to assets ratio. 'CE recap dummy' is a time varying dummy variable that is equal to one after the bank is recapitalized with common equity and zero otherwise. 'Tier1 recap dummy' is a dummy variable that is equal to one after the bank is recapitalized with Tier1 capital (including CE) and zero otherwise.

The results provided in Table 8 strongly suggest that interventions with common equity are particularly effective, notably in comparison with interventions using a wider range of Tier 1 capital. Independent of whether we use country and year fixed effects (columns 1–2), country*year fixed effects (columns 3–4) or bank and year fixed effects (columns 5–6), the point estimate is highly significant and ranges between 0.020 and 0.043. If we add an additional control for general Tier 1 provisions (including CE) the point estimates are negative whilst point estimates for CE interventions increase.

Lending further support to the insight that the specific features of common equity are driving the positive point estimate, we find no significant coefficient in an unreported regression that includes the dummy variable for 'Tier 1 recap' but not for 'CE recap'.

In addition to recommending interventions with higher risk-absorbing potential, these results may again also be interpreted in view of *ex ante* regulation; they seem to suggest, for example, that financial stability authorities may be well-advised to adopt even narrower regulatory definitions for capital ratios than those currently proposed by the Basel Committee.[16]

Table 8 also introduces the question as to why common equity provisions seem to be so much more effective. The existing theories, as discussed in Section 2, are inconsistent with our evidence since they either recommend interventions with preference shares (Philippon and Schnabl, 2010) or require that banks are not liquidity constrained (Wilson, 2009; Wilson and Wu, 2010). We therefore conclude that further research is needed, and offer the following conjecture for discussion: since common equity provisions are associated with lower risks for the banks than, for example, preference shares, they signal a stronger commitment by the government to relieve a bailed out intermediary from remaining risks. As a result, the recapitalized bank will be able to refinance itself more easily and, consequently, to lend more.

In summary, the presented evidence shows that conditional upon the decision to provide public support to distressed financial institutions, governments should do so decisively. That is, they should provide sufficient amounts of capital, but they should also commit to actually reducing the banks' risk exposure as much as possible. If they fall short of these requirements, it seems that public interventions fail to provide the desired incentives for improved bank lending. In light of the cross-country differences with respect to the design of public interventions (Table 1), these results then suggest that the German approach has been more effective than, for example, the French approach.

5.1.3. Timing. In this section, we examine whether recapitalizations that were conducted 'Early', that is, during the first half of our sample period, exhibit a different relation to credit growth than recapitalizations that were provided during the second half (i.e. 'Late').[17]

[16] The European Banking Authority (2011) does indeed emphasize the choice of common equity over preference shares for the definition of Core Tier 1 capital that they adopt for their recommended capital buffers.

[17] For cases where a bank received multiple recapitalizations, we consider the date of the first intervention the relevant one.

Different effects could, for example, be attributed to the fact that early measures were generally intended to address solvency concerns while later ones were more often designed to boost economic activity. Similarly, the first recapitalizations were often installed as emergency measures, while later ones were typically designed as follow-up programmes.

Following the results presented in Table 9, our conclusion is that the timing of the recapitalization is of minor relevance: whether we measure recapitalizations as a continuous variable (column 1), a dummy variable (column 2) or with dummies for high (column 3) or common equity (column 4) provisions, the timing of the recapitalization plays no statistically significant role.

In the first two cases, we do not find any significant impact; instead, for large and CE provisions the coefficients on 'Early' and 'Late' interventions are significant and point estimates for 'Early' recapitalizations are somewhat, but not significantly, higher (according to Table 9, p-values are equal to 0.64 in the case of 'High' provisions and 0.21 in the case of recapitalizations with CE).

Table 9. Effect of 'early' and 'late' recapitalizations on relative loan growth

	(1)	(2)	(3)	(4)
Recapitalization × Early	0.018			
	(0.012)			
Recapitalization × Late	0.006			
	(0.004)			
Recap dummy × Early		0.003		
		(0.008)		
Recap dummy × Late		−0.007		
		(0.006)		
High recap dummy × Early		0.023**		
			(0.009)	
High recap dummy × Late			0.019**	
			(0.008)	
CE recap dummy × Early				0.029***
				(0.009)
CE recap dummy × Late				0.015**
				(0.006)
Test: Early=Late (*p*-value)	0.41	0.32	0.64	0.21
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Number of observations	1387	1387	1387	1387
R-squared	0.06	0.06	0.07	0.07

Notes: Standard errors clustered by country in parentheses.

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. The dependent variable is the year-to-year change in the loan to assets ratio. Loans include all household and corporate loans. 'Early' is a dummy variable equal to one if the bank was recapitalized during the first half of the sample period and zero otherwise. 'Late' is a dummy variable equal to one if the bank was recapitalized during the second half of the sample period, and zero otherwise. In column (1), 'Recapitalization' is the cumulative amount of capital received, scaled by 2006 equity levels. In column (2), it is the corresponding dummy variable for being recapitalized. In column (3) 'High Recap dummy' is a dummy that takes value one after the bank receives a 'High' capital injection (>75th percentile). In column (4), 'CE Recap dummy' is a dummy equal to one after the bank is recapitalized using common equity.

A related concern, that we have addressed in unreported regressions, is one of lagged effects of recapitalization. We have estimated the model to include the number of quarters since recapitalization as a regressor, but found no significant effect.[18]

5.1.4. Bank characteristics. Having identified large recapitalizations and interventions with common equity as most effective, a natural subsequent question to ask is whether loan growth responds differently, depending upon bank specialization, and more specifically, upon whether the banks' operations can be primarily defined as either 'Local' or 'Global'.

The corresponding hypothesis, namely that local banks respond to capital injections by providing relatively more credit, relies on theoretical and empirical work suggesting that close relationships between banks and firms improve the flow of credit by reducing information asymmetries.[19] At the same time, it is also at the core of an initiative that the US administration launched in October 2009. Specifically, President Obama motivated the Administration's focus on local banks as follows:

> [In order to] spur lending to small businesses, it's essential that we make more credit available to the smaller banks and community financial institutions that these businesses depend on. These are the community banks who know their borrowers; who gave them their first loan; who've watched them grow from down the street – not from Wall Street' (Obama, 2009).

Therefore assessing the empirical validity of the link between local orientation and credit growth is not only relevant for the cited literature, but also provides important feedback on recent policies. To address the question formally, we split our bank sample into 'Local' (i.e. Cooperative and Savings) and 'Global' (i.e. Investment and Commercial), and augment the benchmark model with the corresponding dummy variables; that is, we interact the 'recapitalization' variable in specification (II) with a dummy variable that identifies each bank as either 'Local' or 'Global'.

The results of this exercise, presented in Table 10, show that, in contrast to the political rationale, the marginal effect of public capital provisions for local banks is, if anything, lower than for globally active banks. The point estimates of the coefficient on recapitalizations turns out to be either insignificant for local banks (columns 1–3) or significantly higher (column 4) for 'Global' banks; more specifically, there is no statistically significant difference if we measure 'recapitalization' as a continuous variable (column 1), with a dummy variable (column 2) or with a dummy for 'Low' capital provisions (column 3), while, if recapitalization is measured by a dummy for

[18] We would also have liked to address the question of whether multiple interventions have a different effect than single interventions. However, since only 14 banks in our sample received multiple recapitalizations, we were left with too few observations for a meaningful empirical analysis.

[19] The vast literature on the link between information asymmetries and bank lending goes back to the 1980s. Contributions include among others Diamond (1984, 1989), Petersen and Rajan (1994), Cole (1998), Ongena (1999), Boot (2000) and Berger and Udell (2002).

Table 10. Effect of recapitalization on relative loan growth of 'Local' and 'Global' banks

	(1)	(2)	(3)	(4)
Recapitalization × Local	0.010			
	(0.006)			
Recapitalization × Global	0.012**			
	(0.005)			
Recap dummy × Local		0.006*		
		(0.003)		
Recap dummy × Global		−0.003		
		(0.005)		
High Recap dummy × Local			0.023	
			(0.014)	
High Recap dummy × Global		0.021***		
			(0.006)	
CE Recap dummy × Local			0.012***	
				(0.004)
CE Recap dummy × Global				0.026***
				(0.007)
Test: Local=Global (*p*-value)	0.75	0.06	0.83	0.11
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Number of observations	1387	1387	1387	1387
R-squared	0.06	0.06	0.07	0.07

Notes: Standard errors clustered by country in parentheses.

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. The dependent variable is the year-to-year change in the loan to assets ratio. Loans include all household and corporate loans. Recapitalization in column (1) is the cumulative amount of capital received scaled by 2006 equity levels, in column (2) recapitalization is a dummy that takes the value one after a bank is recapitalized. In column (3) the dummy variable is equal to one after a bank received a 'High' capital injection (>75th percentile), and in column (4) after it was recapitalized with common equity. Otherwise the dummy variable is equal to zero.

interventions with CE, the analysis identifies the coefficient for recapitalizations of local banks to be significantly lower.

In summary, the evidence presented in this paper challenges policy proposals and the corresponding literature that intend to promote economic recovery through loans to local banks. Hence, whilst we do not question the relevance of relationship banking in general, we show that its importance for the provision of credit during crises may have been overstated, and that the effect on credit in the US may have potentially been even stronger without the local lender initiative, provided that an identical amount of capital had been allocated to Investment or Commercial banks.

Considering, also, that to date many of the larger banks have already repaid their obligations towards the Treasury, while many smaller banks continue to struggle with their interest payments, we believe that our evidence calls into question the effectiveness of programmes that seek to fuel a real recovery by targeted recapitalization of local banks.

5.1.5. Robustness to an alternative estimation method. While we have addressed the issue of robustness to a certain extent by varying the inclusion of fixed

effects and the definition of our key variables, the benchmark model is still subject to several drawbacks; most importantly, if our point estimates should be interpreted as causal or if they suffer from endogeneity. In this section, we provide some additional discussion regarding these issues.

First, the fact that we find banks with lower Tier 1 capital ratios and fewer liquid assets to be recapitalized with a higher probability, suggests that these banks were more fragile and thus, on average, less inclined to increase loan growth during the crisis. Under this assumption, our coefficients would actually be biased *downwards* and can, in fact, be interpreted as a lower bound.

Secondly, we address the issue of causality, by estimating a Propensity Score Matching (PSM) model. The corresponding estimation strategy relies to an important degree on the small sample properties of the models analysed by Dehejia and Wahba (2002). That is, using a Probit model as in Section 4, we calculate the probabilities of banks being recapitalized based upon observable banks' characteristics (propensity scores) and proceed to compare the credit supply of those banks that were actually recapitalized with those that have similar propensity scores but ended up not receiving public recapitalization. In particular, we match each recapitalized bank with the single comparison unit that has the most similar propensity score, and then select units with replacement, that is, allow for one non-recapitalized bank to be matched with multiple recapitalized banks.[20] The single most important assumption that would guarantee a causal interpretation of the point estimates in Table 11 is one of a 'common trend', that is, an assumption that both recapitalized and non-recapitalized banks would have experienced similar changes in loan growth if one sub-sample had not received the public provision.

The corresponding results in column (2) of Table 11 confirm not only the sign of the point estimates for 'High', 'Medium', 'Small' and 'CE' interventions, but are also comparable with respect to their size; the only difference being that the point estimate for small recapitalizations is now *significantly* negative. Following Dehejia and Wahba (2002), and in order to assess the proximity of our matched units, we provide a graphic illustration of the propensity scores in Figure 2, whilst it does not exclude the possibility that matched units differ systematically due to unobservable factors, it does indicate that they are sufficiently similar conditional on observable characteristics.

There are a number of observations that, jointly, support the view that the estimates in column (2) of Table 11 can serve as a lower bound of the causal effect of direct public recapitalizations on loan growth: first, there is some evidence (Table 2 and Table 7) that, if anything, the sub-sample of recapitalized banks experiences lower loan growth in the absence of public provisions; second, the point estimates for 'High' (Table 7) and 'CE' (Table 8) interventions remain essentially unchanged if we

[20] For robustness, we have also matched multiple non-recapitalized banks with each of the recapitalized banks but found no significant difference depending on whether we matched the one, two, three or four 'nearest neighbours' (i.e. the observations that were closest with respect to the estimated propensity score).

Table 11. Effect of recapitalization on relative loan growth (propensity score matching, nearest neighbour method)

	(1) Placebo 2004–7	(2) Average treatment effect
Recapitalizations	0.008***	−0.007*
	(0.003)	(0.003)
High recap	−0.006	0.019**
	(0.006)	(0.007)
Med recap	0.011**	−0.004
	(0.005)	(0.005)
Low recap	0.010**	−0.016***
	(0.004)	(0.006)
CE recap	−0.009	0.029***
	(0.007)	(0.009)

Notes: **, ***, denote statistical significance at the 5% and 1% level, respectively. Matching is based on variables that are statistically significant in column (1) of Table 3 and column (3) of Table 4. High recap' includes all 'Recapitalizations' above the 75th percentile, 'Medium recap' refers to those between the 25th and 75th percentile and 'Low recap' includes all capital injections in the 25th percentile.

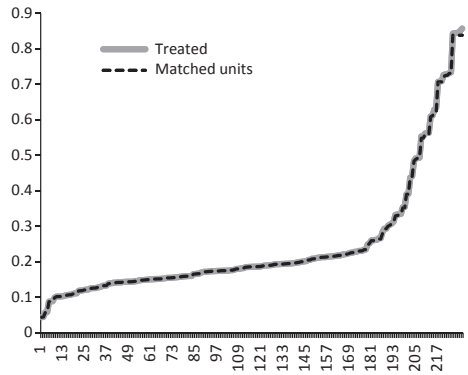

Figure 2. Propensity scores for treated and matched units

Notes: Solid line represents the recapitalized banks; dashed line the nearest neighbours. The two lines almost perfectly overlap.

introduce bank fixed effects, suggesting that unobservable components do not play an important role in the determination of the banks' loan growth. Finally, the placebo estimation for a non-crisis sample presented, in column (1) of Table 11, confirms that the subsamples are not systematically biased in favour of our estimates.[21] Hence, in summary, the results in Table 11 and Figure 2 support our earlier conclusions, and provide further evidence in favour of the notion that committed (large and truly risk-absorbing) interventions do have the desired positive and economically relevant effects upon banks' lending behaviour.

[21] As we have argued previously, placebo estimations would ideally need to be conducted on a *comparable* period. This, however, is impossible due to the exceptional period that we are interested in.

5.2. Recapitalization, interbank lending and regulatory capital

After having identified the most relevant characteristics of recapitalizations that are effective in promoting loan growth, we now proceed to explore whether and how the direct provisions affect alternative dependent variables: we ask, in particular, whether recapitalizations were successful in restoring the functionality of the interbank market and, in view of the theory of Diamond (2001), explore how recapitalizations affect write-offs and non-performing loans.

5.2.1. Interbank lending. So far the analysis has focused on observations at the individual bank level. However, the industry acknowledges that much of the severity of the financial crisis was owed to its systemic nature, and that financial linkages played an important role with respect to propagation and amplification. Maybe even more importantly, most of the recapitalization programmes were designed precisely with the intention of ring-fencing contagion and preventing the interbank market from freezing. Consequently, it is worth investigating not only to what extent recapitalizations affect interbank lending, but also whether there are positive externalities for other banks in the system.

In order to estimate these 'systemic' effects, we define an aggregate recapitalization variable for each bank i as the sum of the capital that was received by all other banks from the same country ('Others recapitalization'), and include it as an additional regressor in our benchmark model. Since the interbank market arguably played a crucial role in propagating systemic risks, we furthermore redefine the dependent variable and focus on interbank loan growth rather than on retail loans.

The results, presented in Table 12, are surprising and challenge the political rhetoric, according to which public bank recapitalizations were generally without a viable alternative as a means to ensure the functionality of all banks in the financial system: while we estimate a positive and significant coefficient for the effect of recapitalizations on interbank lending (column 1), the coefficient with respect to the aggregate provisions remains robustly negative and insignificant across the different specifications.

Furthermore, the low overall explanatory power of the model suggests that public bank recapitalizations played only a minor role in determining interbank lending and, thus, was only of modest influence in ensuring the stability of the financial system.

We therefore conclude from Table 12 that public recapitalizations can incentivize interbank lending directly, while we find no evidence to support the notion that the recapitalization of banks generates systemic effects and/or positive externalities upon the interbank market.

5.2.2. On the use of bailout capital. Finally we examine, in more detail, how banks use the bailout capital which the public agencies provided. As explained in the introduction, one way for public capital to affect bank lending would be to strengthen the

Table 12. Effect of aggregate recapitalizations on interbank loan growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Recapitalization	0.008*							
	(0.004)							
Recap dummy		0.004						
		(0.003)						
High recap dummy			0.003	0.002	0.009	0.006	0.010**	0.009*
			(0.005)	(0.005)	(0.006)	(0.006)	(0.004)	(0.004)
Med recap dummy			0.005	0.005	0.005	0.004	0.005	0.005
			(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)
Low recap dummy			−0.001	−0.000	−0.001	0.000	−0.003	−0.001
			(0.003)	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)
Others recapitalization	−0.029	−0.030	−0.029	−0.044	−0.032	−0.060	0.004	−0.077
	(0.052)	(0.051)	(0.051)	(0.052)	(0.052)	(0.052)	(0.061)	(0.075)
Country FE	Yes	Yes	Yes	No	Yes	No	Yes	No
Year FE	Yes	Yes	Yes	No	Yes	No	Yes	No
Country × Year FE	No	No	No	Yes	No	Yes	No	Yes
Number of observations	1355	1355	1355	1355	1327	1327	1062	1062
R-squared	0.01	0.01	0.01	0.06	0.01	0.06	0.02	0.08

Notes: Clustered standard errors (by country) are provided in parentheses.

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. The dependent variable is the year to year change in the ratio of interbank loans to total assets. In column (1), 'Recapitalization' is a continuous cumulative variable equal to the total amount of capital that was provided to the bank (scaled by 2006 equity levels). In column (2), 'Recap dummy' is a dummy variable equal to one after the bank was recapitalized. In columns (3)–(8), 'High recap' includes all 'Recapitalizations' above the 75th percentile, 'Med. recap' refers to those between the 25th and 75th percentile and 'Low recap' includes all capital injections in the 25th percentile. In columns (3)–(4), the underlying recapitalization variable is scaled by 2006 equity. In columns (5)–(6) it is scaled by 2006 total regulatory capital and in columns (7)–(8), by 2006 risk-weighted assets. 'Others recapitalization' is the sum of all recapitalizations provided to all other banks in the same country scaled by their aggregate equity.

regulatory capital base. In Table 13, therefore, we analyse how recapitalizations relate to changes in regulatory capital generally (Tier 1 and Tier 2), and to Tier 1 capital in particular. The findings suggest that banks that received public capital injections also experience faster growth in regulatory capital. This effect appears to be particularly strong for the higher quality Tier 1 capital and is larger for large recapitalizations, suggestive of the fact that banks are willing to turn additional capital into credit only once they have sufficiently buffed up regulatory capital ratios. Hence, public recapitalizations do indeed seem to be associated with a stabilization of the bank; these findings are consistent with what regulators wanted to achieve (and frequently promoted through corresponding management requirements) and thus are supportive of recent policy efforts.

In order to provide further support to our underlying claim that recapitalizations generally correspond to a stabilization of fragile financial intermediaries, we exploit two other variables that are available in the *Bankscope* database: write-offs (Table A5, Panel a) and NPLs (Panel b). While not generally significant, the results, in both tables, suggest that the relationship between provision of public capital and write-offs and non-performing loans is negative. They are, therefore, consistent with the notion that public intervention induces banks to adopt a more sustainable strategy; more specifically, they suggest that a recapitalized bank's loan portfolio becomes, on average, less risky.

Table 13. Effect of recapitalizations on regulatory capital

	(1)	(2)	(3)	(4)	(5)	(6)
	Change in regulatory capital			Change in Tier1 capital		
Recapitalization	1.508			1.351**		
	(0.930)			(0.589)		
Recapitalization dummy		0.903**			0.921**	
		(0.410)			(0.323)	
High recap dummy			1.282			1.132**
			(0.900)			(0.528)
Med recap dummy			0.574			0.718
			(0.559)			(0.454)
Low recap dummy			0.806**			0.880***
			(0.332)			(0.246)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1278	1278	1278	1247	1247	1247
R-squared	0.03	0.03	0.03	0.03	0.03	0.03

Notes: Standard errors clustered by country in parentheses.

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. In columns (1)–(3), the dependent variable is the change in the ratio of total regulatory capital (Tier1 and Tier2) to total assets. In columns (4)–(6), it is the change in the ratio of Tier1 capital to total assets. In columns (1) and (4), 'Recapitalization' is a continuous variable measuring the size of the intervention (scaled by total assets); in columns (2) and (5), 'Recapitalization dummy' is a dummy variable equal to one if a bank received a public recapitalization. In columns (3) and (6), 'High recap dummy' is a dummy variable equal to one if the received capital provision (scaled by total assets) is larger than the 75th percentile; 'Med recap dummy' is a dummy variable equal to one if the received capital provision (scaled by total assets) is between the 75th and the 25th percentile; 'Low recap dummy' is a dummy variable equal to one if the received capital provision (scaled by total assets) is below the 25th percentile.

The interpretation that public recapitalization does indeed have an effect on portfolio quality is supported, in addition, by the fact that NPLs are typically known to be countercyclical (e.g. Nkusu, 2011). Consequently, a hypothetical, spurious regression would bias the results towards a positive coefficient during recession years.

The effect on write-offs and NPL is also interesting when contrasted with the theory of Diamond (2001). Specifically, it predicts that better capitalized banks will be more likely to dispose of loans that are considered non-performing. Hence, the (insignificant, but) negative coefficients in Table A5, Panel b would conform to the underlying rationale if they arise from a higher rate of write-offs *out of NPL*. Unfortunately we are not able to test this channel, and the results on overall write-offs are not sufficiently robust to either confirm or reject the theory. Hence, we can only conclude that there are, in particular, two stylized facts that lend support to the theoretical efforts of Diamond (2001): a positive coefficient on lending only for large capital provisions, and a negative coefficient on NPLs. We acknowledge, however, that more work, and a better quality of data on non-performing loans and write-offs than reported in *Bankscope*, is needed for a definitive conclusion.[22]

In summary, the robust feature of the estimates that we report in Table 13 and Table A5 is that recapitalized banks seem to be more 'stable' and to pursue a more sustainable strategy. They accumulate more high quality capital, specifically Tier 1, and there is evidence that they also strive for a less risky loan portfolio.

6. CONCLUSION

During the ongoing financial crisis, governments have, individually, and in coordination with each other, dedicated substantial resources to the stabilization of the global financial system that, if allowed to collapse, would have threatened to amplify a deep economic recession into a second Great Depression. The form of these interventions either drew upon experiences that dated back almost 80 years, or were very specific to particular cases (e.g. LTCM) or countries (most notably Japan). With richer data becoming available, we can now analyse the success of these programmes, identify opportunities for improvement and provide policymakers and regulators alike with guidance on how to prevent, and more importantly how to resolve, future financial distress at minimal cost.

For this paper, we have assembled this data from various publicly available sources (see Data Appendix available online) and combined it with balance sheet information from the *Bankscope* database. This enabled us to analyse comprehensive bank level

[22] Banks do not always report data on write-offs and NPLs accurately or in a timely way and many banks do not report NPLs at all. Further according to *Bankscope* definitions, these variables vary across countries. Hence, given the relatively poor quality of the data, we consider the existing evidence valuable in combination with the information that we provide on regulatory capital, but suggest it should not be interpreted as a rejection (or a definitive empirical verification) of the work of Diamond (2001).

data, and to study recapitalization events, as well as the role of recapitalization size and of the provided capital's risk-absorbing properties.

As a first step towards resolving the questions of efficient crisis resolution, we study the relationship between public capital injections and year-to-year changes of banks' propensity to lend. We analyse the role of bank characteristics and bailout features, specifically with respect to the banks' ability to promote lending and to accumulate regulatory capital.

Our analysis shows that successful public interventions in 2008–9 were conducted via the purchase of common equity, and covered at least 49.22% (and on average approximately 100%) of the recapitalized banks' pre-crisis equity (or, alternatively, 37.34% of its pre-crisis regulatory capital, or 4.70% of pre-crisis RWA). Furthermore, we reject the hypothesis that locally operating (Cooperative and Savings) banks are more likely to increase their lending activity in response to a public bailout, and find no evidence in support of the view that aggregate recapitalizations have significantly improved interbank lending.

While our results are primarily aimed at providing guidance for the design of *ex post* interventions, they are relevant also with respect to recent efforts to harmonize and coordinate the capitalization of European banks *ex ante*. The 'EBA Recommendation on the creation and supervisory oversight of temporary capital buffers to restore market confidence', published by the European Banking Authority (EBA) on 8 December 2011, for example, perpetuates a very narrow definition of Core Tier1 capital that had already been applied during the 2011 EU-wide stress test, and that 'comprises the highest quality capital instruments (common equity)' (EBA, 2011, p. 9). In particular, it 'strips out hybrid instruments, including … preference shares' (EBA, 2011, p. 9) from the definition of Tier1 capital that is commonly used by the bodies of the European Union (EU). Since we have found common equity, but not preference shares, to correspond with increased bank lending, and since the EBA Recommendation is explicitly concerned with maintaining credit supply to the European Economic Area (EEA), our results provide empirical support in favour of this directive.[23] In addition, the EBA now recommends that banks hold Core Tier1 capital amounting to 9% of RWA by 30 June 2012. Our results with respect to the determinants of *ex post* recapitalizations suggest that such requirements reduce not only the probability that banks will need to be publicly supported, but also the conditional costs in the event of a future crisis.

Furthermore, the EBA formulates the need for 'exceptional efforts to restore confidence in the banking sector' (EBA, 2011, p. 4) and the hope that 'the capital target … is not achieved through … disrupting lending into the real economy and cognisant of the broader context, including availability of bank funding' (EBA, 2011, p. 5). Whilst

[23] The Recommendation calculates the Core Tier1 capital ratio as the ratio between Core Tier1 capital and risk-weighted assets (RWA); while we are favourable of their definition of Core Tier1 capital, we acknowledge that the issue of risk-weights remains an important one; especially if banks are permitted to use internal models in order to determine them.

we are sympathetic to the underlying argument, our results, specifically on interbank lending, suggest that capital buffers alone may be insufficient to restore confidence or the availability of bank funding during crises: providing more public capital did not correspond with significantly higher loan growth on the interbank market.

Since the events of 2008, the academic and political debate have generated many regulatory proposals aimed at stabilizing a fragile financial sector. However, while much has been written on proactive regulation, there is still relatively little information available to guide the design of *ex post* interventions.[24] Yet, with the discussion evolving towards structured resolution mechanisms (Dewatripont & Rochet, 2010; Freixas, 2010), this information will become essential. Alleviating moral hazard requires credible commitment to *ex ante* formulated rules, and credibility, in turn, requires these rules to be thoughtfully designed. The main contribution of this paper is to provide necessary information for such a design.

We are the first to acknowledge that policymakers have other options than directly providing fragile banks with capital and that the effect on credit is only one of many relevant variables for future study. Other topics might include the relationship to profitability, to dividend payments and asset prices, and also to interest rate spreads. These issues are beyond the scope of this paper; however, our data contains more detail than we have processed here, and will allow us to address them in future work.

With respect to theoretical research, this paper has pointed the way towards future investigation, particularly into Diamond's (2001) theory and into the analysis of the non-linear and adverse incentive effects of public capital injections. In addition, it has emphasized that more work needs to be done to provide a satisfactory explanation for the beneficial role that common equity injections have played and to assess the role of capital quality for bank lending.

Discussion

F. Kramarz

CREST

In this very interesting and useful paper, the authors look at recapitalization episodes over a very recent period. To do so, they use banks' measures of the pre- and post-recapitalization episodes for a relatively large set of countries. They focus on a limited but important set of outcomes such as the propensity to be recapitalized; if recapitalized, the size, timing, structure of recapitalization. Then, after recapitalization, they investigate the propensity to lend as well as interbank lending.

[24] For instance, there is no empirical work that assesses the relative effectiveness of direct recapitalizations of the type examined in this paper as opposed to indirect recapitalizations via the interest rate spread as discussed, for example, in Leijonhufvud (2011).

First, let me congratulate the authors for the quality of the final version, as seen from a reader of the earlier versions. It is just a different paper with lots of serious and convincing empirical elements on a topic which is, most of the time, a subject of discussion rather than an object of study. This analysis comes at a timely moment and will clearly give food for thought to those in charge of devising policies in this field.

I still have one general question and one frustration about this project. From the start, I was struck both at this descriptive stage as well as at the regression stages by the authors' strategy. For them, various countries under study are essentially treated as equivalent. However, institutions differ widely, in particular the role of the State, or the states. In addition, the nomination of the banks' CEOs vary from country to country, hence the CEOs' independence; similarly for the ownership structure (private versus public owners). Not being knowledgeable in the banking business, I would have resorted to interviews of regulation authorities in various countries to check what may be missing, in terms of data.

For instance, various tables show the different forms of bank resolution – recapitalimerger and nationalization – and the authors try to analyse the different choices. Thinking about the institutional perspective mentioned above, I would have found it useful to have a sense of the 'country effects' (not in an econometric sense, though). In particular, the variables explaining the choices are indeed simultaneously very informative and hide many institutional/political decisions. Among others, a basic question that comes to mind is: are the various country choices based on rational/economic reasons or based on national considerations, including institutions – or politically based? Were these episodes associated with changes in the CEOs of the banks involved? For instance, the timing is used (early versus late) in Table 9. Is the early versus late choice correlated with institutions, changes in CEOs, changes in the political environment? Similar questions can be posed for Table 10 on 'global versus local' or on most other choices.

To summarize, this paper is a very interesting and useful look at the recent episodes of bank distress and the associated recapitalization attempts. The recent developments tend to show that the nature of the problems (for instance, if difficulties stem from the construction industry or from something completely different) interact with the political process and the nature of the solutions that are suggested or found. Since this aspect has not been envisaged by the authors, there is room for new innovative studies to inform policymakers and academics trying to solve our financing problems and 'help' the banking industry.

Panel discussion

Thorsten Beck recommended that the authors also look at the literature on the resolution of banking crises in emerging economies. He also questioned whether it would be

possible for the authors to obtain data on non-performing loans of banks in order to better assess the ultimate consequences of loan growth. He also commented on the recapitalization and timing variables, and suggested that the authors look at recapitalization relative to the equity gap (the need for capital). Patrick Bolton suggested using the amount of bad loans written off by banks as another efficiency measure for loan growth. Furthermore, Bolton argued that it would have been interesting to examine the effects of public recapitalizations on the aggregate credit growth of the banking system. Fabiano Schivardi suggested that the authors check whether there were any changes in management or the board at the time of recapitalization in order to ensure that it is indeed the recapitalization that is driving loan growth. Carlos Mulas-Granados asked whether the results would change if one considers market-based recapitalizations since these are sought prior to the state intervening. Andrea Ichino was interested in the reasoning behind the use of propensity score matching. Philippe Martin contended that a lot of the banks were taking on large amounts of risk in anticipation of eventually being bailed out. Therefore, he asks if the authors could check whether banks with higher riskier returns were recapitalized to a greater extent (during the years 2007–8). Regarding the econometric specification, Nicola Fuchs-Schündeln wanted to know if the authors were only examining the variation in the amount of recapitalization, and if so, why do they not further exploit the time variation in the data. In reply to the questions, Mariathasan confirmed that fixed effects were included in the empirical specification, and acknowledged that extending the dataset past the end of 2009 would improve the time dimension. Regarding Beck's remark on NPLs, Mariathasan noted that NPLs were accounted for in the study, but that they were not able to examine bad debt write-offs as an alternative variable.

APPENDIX

Table A1. Summary Statistics (Other Variables)

	Mean	s.d.	Mean non-recapitalized banks (1)	Mean recapitalized banks (2)	s.d. recapitalized banks	Test (1)=(2) *p*-value
Tier1 RWR	11.72	8.81	12.13	10.11	9.66	0.04
Ln(total assets)	0.17	0.02	0.17	0.17	0.02	0.34
Liquidity	0.16	0.17	0.16	0.14	0.18	0.38
Loans/deposits	5.56	28.95	6.31	2.52	31.74	0.23
Provisions	0.00	0.00	0.00	0.00	0.00	0.27
NPL	0.02	0.02	0.02	0.02	0.02	0.44
Return on assets	0.89	0.79	0.86	1.10	0.59	0.00
Long-term funding	18.24	20.41	17.99	19.65	18.96	0.52
Non-deposit funding	24.66	25.06	24.82	23.75	18.93	0.22
Liabilities/GDP	0.10	0.28	0.08	0.21	0.46	0.00

Table A1. (Continued)

	Mean	s.d.	Mean non-recapitalized banks (1)	Mean recapitalized banks (2)	s.d. recapitalized banks	Test (1)=(2) *p*-value
Debt to GDP ratio%	70.33	50.17	74.66	52.63	32.54	0.00
Budget balance to GDP ratio%	0.38	5.04	0.19	1.16	6.17	0.08

Notes: 'Tier1' is the risk-weighted capital ratio. 'Liquidity' includes liquid assets (including government bonds) and loans and advances with maturities of less than three months. 'Deposits' are aggregate (savings and demand) customer deposits. 'Provisions' are loan loss provisions scaled by total assets. The value of 'NPL' is scaled by total gross loans. 'Long-term funding' is in percentage of total funding and 'Non-deposit funding' is in percentage of total short-term funding. All explanatory variables are Winsorized at the 1% and 99% level. The last column is the two-tailed *p*-value of *t*-test allowing for differences in variance between the recapitalized and non-recapitalized banks.
Source: Collected data (see Data Appendix available online), Bankscope.

Table A2. Correlation matrix (dependent variables)

	(1)	(2)	(3)	(4)	(5)	(6)
(1)	1					
(2)	0.711*	1				
(3)	0.329*	0.193*	1			
(4)	−0.052*	0.025	−0.002	1		
(5)	0.026	0.023	0.001	−0.307*	1	
(6)	0.185*	0.135*	0.271*	−0.005	0.009	1

Notes: This panel reports Pearson correlations among selected variables.

* denotes statistical significance at the 5% level and above. Variables: (1) Recapitalization dummy, (2) (Own) Recapitalization size, (3) Others Recapitalization size, (4) Loans(t)/ Assets(t) – Loans(t–1)/ Assets(t–1), (5) Interbank Loans(t)/ Assets(t) – Interbank Loans(t–1)/ Assets(t–1), (6) Write Offs(t)/ Write Offs(t–1).
Source: Collected data (see Data Appendix available online), Bankscope.

Table A3. Correlation matrix (control variables)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	1											
(2)	0.699*	1										
(3)	−0.094*	−0.111*	1									
(4)	−0.039	−0.044	0.202*	1								
(5)	−0.052	−0.039	−0.000	−0.055	1							
(6)	−0.043	−0.000	0.019	−0.107*	0.206*	1						
(7)	−0.036	0.059	−0.183*	0.027	0.053	0.328*	1					
(8)	0.034	0.021	−0.326*	0.116*	−0.016	0.019	0.065	1				
(9)	−0.053	−0.018	0.211*	0.272*	−0.009	−0.059	0.004	−0.016	1			
(10)	−0.033	−0.039	−0.020	0.128*	−0.036	−0.019	0.104*	0.124*	−0.048	1		
(11)	−0.084*	−0.029	−0.089*	−0.088*	0.063	−0.101*	−0.109*	0.037	−0.058	−0.067	1	
(12)	0.009	0.003	−0.073	−0.156*	−0.059	−0.047	−0.210*	−0.214*	−0.084*	−0.097*	−0.115*	1

Notes: This panel reports Pearson correlations among selected variables.

* denotes statistical significance at the 5% level and above. Variables: (1) Recapitalization dummy, (2) (Own) Recapitalization size, (3) Tier1 capital, (4) Liquidity, (5) Loan/Deposit, (6) Provisions, (7) Non-performing loans, (8) ln(total assets), (9) Investment bank, (10) Cooperative banks, (11) Real estate bank, (12) Savings bank.*Source*: Collected data (see Data Appendix available online), Bankscope.

Table A4. Effect on the time (in quarters) to recapitalization

	(1)	(2)	(3)	(4)	(5)
Tier1 Capital	−0.114***	−0.120***	−0.150***	−0.136***	−0.180***
	(0.022)	(0.024)	(0.026)	(0.029)	(0.046)
Liquidity	−3.283***	−2.413**	−2.941***	−3.448***	−2.578**
	(0.993)	(1.115)	(1.069)	(1.132)	(1.223)
Loan/Deposits	−0.013	−0.029	−0.020	−0.027	−0.030
	(0.017)	(0.034)	(0.017)	(0.029)	(0.030)
Provisions	−21.502	−16.581	−29.750	−43.750	−32.427
	(57.882)	(46.117)	(46.477)	(54.367)	(58.502)
Non-performing loans	4.166	7.288	5.954	4.474	14.483
	(5.021)	(4.800)	(5.094)	(4.930)	(8.938)
Ln(total assets)	20.003*	15.830	10.560	21.242	2.254
	(10.784)	(11.271)	(7.772)	(23.148)	(7.714)
Investment banks	0.927	1.048	1.804**	1.793**	2.047***
	(1.275)	(0.999)	(0.723)	(0.768)	(0.586)
Cooperative banks	0.315	0.430	−0.398	−0.062	−0.235
	(0.572)	(0.550)	(1.296)	(1.268)	(1.299)
Real estate banks	−1.566***	−1.565***	−1.024	−1.411**	−0.538
	(0.482)	(0.551)	(0.719)	(0.571)	(0.815)
Savings banks	−0.340	−0.295	−0.774	−0.598	−0.415
	(0.850)	(0.883)	(0.820)	(0.989)	(0.770)
Return on assets		0.227	0.211	0.123	0.271
		(0.163)	(0.170)	(0.113)	(0.215)
Long term funding		0.0142	0.014	0.012	0.020*
		(0.011)	(0.014)	(0.013)	(0.012)
Non-deposit funding		−0.007	−0.010*	−0.011	−0.013**
		(0.005)	(0.006)	(0.007)	(0.006)
Systemic bank dummy (SD)			1.970***	2.122*	2.702***
			(0.548)	(1.171)	(0.770)
(Debt/ GDP) × SD			−0.020	−0.043***	−0.020
			(0.013)	(0.016)	(0.013)
(Budget deficit/ GDP) × SD			−0.206**	−0.361***	−0.172***
			(0.093)	(0.135)	(0.064)
Country FE	Yes	Yes	Yes	Yes	Yes
Number of banks	392	383	375	375	375

Notes: Standard errors clustered by country in parentheses.

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. Coefficient estimates from a Cox proportional hazard model are reported. Hazard ratios are obtained by taking the exponential of the coefficient estimates. 'Systemic bank dummy' is a dummy variable equal to one if Liabilities/ GDP > 0.05 in column (3); if Liabilities/ GDP > 0.10 in column (4) and if Liabilities/ GDP > 0.25 in column (5).

Table A5. Effect of recapitalization on asset quality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel a. Write-offs								
Recapitalization	0.038							
	(0.133)							
Recap dummy		−0.019						
		(0.067)						
High recap dummy			−0.103	−0.169	−0.171***	−0.310**	0.054	−0.005
			(0.140)	(0.159)	(0.043)	(0.127)	(0.179)	(0.130)
Med recap dummy			0.011	−0.004	−0.001	−0.011	0.022	0.005
			(0.045)	(0.055)	(0.069)	(0.081)	(0.099)	(0.108)
Low recap dummy			−0.195	−0.122	0.022	0.048	0.003	0.020
			(0.150)	(0.184)	(0.081)	(0.138)	(0.118)	(0.150)
Number of observations	1356	1356	1356	1356	1326	1326	1064	1064
R-squared	0.11	0.11	0.11	0.18	0.10	0.17	0.13	0.23
Panel b. Non-performing loans								
Recapitalization	−0.144							
	(0.359)							
Recap dummy		−0.506						
		(0.564)						
High recap dummy			−0.156	−0.420	−0.308	−0.568	−0.220	−0.210
			(0.333)	(0.404)	(0.350)	(0.402)	(0.501)	(0.489)
Med recap dummy			−0.295	−0.567**	−0.323	−0.606**	−0.157	−0.357
			(0.261)	(0.244)	(0.274)	(0.268)	(0.392)	(0.322)
Low recap dummy			−1.766	−1.798	−3.223	−3.362	−4.451	−4.798
			(1.686)	(1.709)	(3.029)	(3.057)	(4.392)	(4.630)
Number of observations	1131	1131	1131	1131	1107	1107	938	938
R-squared	0.13	0.13	0.14	0.20	0.14	0.21	0.14	0.20

Notes: Clustered standard errors (by country) are provided in parentheses

***, **, * denote statistical significance at the 1%, 5% and 10% level, respectively. The dependent variable is the change in the ratio of write-offs to gross loans. In column (1), 'Recapitalization' is a continuous cumulative variable equal to the total amount of capital that was provided to the bank (scaled by 2006 equity levels). In column (2), 'Recap dummy' is a dummy variable equal to one after the bank was recapitalized; in columns (5)–(6), the underlying recapitalization variable is scaled by 2006 total regulatory capital. In columns (7)–(8), it is scaled by 2006 risk-weighted assets. In column (3)–(8), 'High recap' includes all 'Recapitalizations' above the 75th percentile, 'Med recap' refers to those between the 25th and 75th percentile and 'Low recap' includes all capital injections in the 25th percentile. All columns include country and year fixed effects, columns (4), (6) and (8) include country*year fixed effects.

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