On Zombie Banks and Recessions after Systemic Banking Crises: Government Intervention Matters

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Abstract

What costs do zombie banks impose on society? We analyze the effects of government and central bank interventions in 68 systemic banking crises since 1980, of which 28 are part of the recent global financial crisis. Our estimation approach controls for the correlation between intervention measures and the time-invariant component of unobservable crisis severity. We find that timely bank recapitalization substantially reduces the duration of recessions, underscoring the distortions caused by zombie banks and the costs of regulatory forbearance.

Key words: Financial crises, zombie banks, regulatory forbearance, intervention, bank recapitalization, economic recovery

JEL codes: E44, E58, G21, G28

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As early as 2009, Reinhart and Rogoff (2009a) pointed out that "recessions surrounding financial crises are usually long compared to normal recessions". Their research highlights surprisingly large declines in output, slow recoveries and large and persistent negative effects on unemployment, public debt and fiscal deficits in the aftermath of banking crises. The subsequent experiences in the United States and particularly in Western Europe seem to lend further support to their findings. Interventions during financial crises are not important just to preserve the key functions of the financial system but also to mitigate the macroeconomic consequences of financial distress. What are the true costs of forbearance i.e. the costs that zombie banks impose on society? In particular, what impact does regulatory forbearance have on recession duration? And what can we say about alternative modes of intervention? In this paper we begin to answer those questions by empirically investigating durations of recessions after 68 systemic banking crises from the period 1980 to 2013.

The existing literature has documented that intervention measures have high fiscal costs (Honohan and Klingebiel 2003). Whether the measures shorten recessions is less clear. Claessens et al. (2005) find that the fiscal costs of banking crises and output loss depend on the quality of institutions, but they do not discuss the nature of the interventions taken. Laeven and Valencia (2011) provide suggestive microeconomic evidence that the mode of intervention matters: they show that in times of banking crisis firms more dependent on external finance grow faster when bank recapitalizations are done. We investigate how effective intervention measures are from a macro perspective: how do they affect recession duration? The main instrument we focus on is bank recapitalization. We find that it substantially reduces recession duration. We also look at other intervention mechanisms such as liquidity support and guarantees on bank liabilities but find little or no positive effect of these measures on the expected recession duration.

Using a duration model on a panel dataset, enables us to take into account that intervention is endogenous to crisis severity. Governments are more likely to intervene in severe than in mild crises. We think about crisis severity as of a measure of the scale of problems in the banking sector, which would determine recession duration if there was no intervention. As such, crisis severity is

not observable. Using a particular policy in a banking crisis affects the probability of recovery and is at the same time informative about crisis severity. If a measure increases the probability of recovery but it is more likely to be used in severe crises, it may appear that the measure is not effective unless the estimation controls for crisis severity. To control for crisis severity, we make some assumptions about its structure. We assume that the severity has two components: a time-invariant component that is correlated with intervention and a time-varying component that is not correlated with intervention. The time-invariant component can be interpreted as the shock to the banking sector that has caused a banking crisis. We let this shock be correlated with the average level of the intensity of intervention over the recession period. Our identification is based on the deviations of intervention from its average over the whole recession period.

The estimation results show that bank recapitalizations, have a highly significant positive effect on the probability of recovery. We calculate the model-predicted recession duration separately for a typical crisis where bank recapitalizations were never done and a typical crisis where banks were recapitalized at some point. Crises with bank recapitalizations are on average much more severe than crises where recapitalizations were not used. The typical recession (from the sample of 2007 to 2013 crises) during which banks were recapitalized is predicted to last 6.3 quarters, but if banks were not recapitalized, the same recession would go on for 11 quarters. For less severe crises (where no recapitalizations took place), the recession is expected to last 5.6 quarters without bank recapitalizations but only 3.5 quarters if banks are recapitalized. These findings strongly document the distortions caused by zombie banks and the costs of forbearance to society.

As an illustration, we start with a theoretical model that analyzes the effectiveness of bank recapitalization. The key inefficiency in the model is that after a shock to the assets, banks may have an incentive to shift risk by rolling over loans to borrowers in distress. Recapitalizing such zombie banks mitigates the incentive problem. Other interventions only prevent bank failures but do not address the incentive problem and therefore do not improve welfare as much as bank

recapitalization. Our empirical results are consistent with the predictions of the model but do not rule out other possible channels.

The paper is organized as follows. Section 1 discusses the related literature. Section 2 presents the theoretical model. The empirical methodology is explained in Section 3 while Section 4 describes the data. Results are presented in Section 5. Robustness checks are in Section 6. Section 7 concludes.

1 Review of related literature

Our paper builds on the empirical literature on financial crises, which documents large output losses and substantial fiscal costs of intervention (Reinhart and Rogoff 2009; Hoggarth, Reis, and Saporta 2002; Honohan and Klingebiel 2003). Several authors focus, like we do, on the interaction between public policy and output losses after a crisis. A critical concern is the endogeneity of policies to crisis severity. To address it Claessens, Klingebiel, and Laeven (2005) look at residual fiscal outlays above the amount predicted by proxies for quality of institutions. They find that higher residual fiscal costs are related to larger output losses. The endogeneity problem can sometimes be circumvented by switching to firm-level data. Kroszner et al. (2007) and Dell'Ariccia et al. (2008) investigate the impact of high dependence on external finance and find that such firms grow relatively slower in times of banking crises. Using the same approach, Laeven and Valencia (2011) find that bank recapitalizations have a positive effect on growth of financially dependent firms. We control for the endogeneity of policies by modeling the crisis severity as a crisis-specific fixed effect that can be correlated to the average level of intervention over the quarters of a crisis.

In the paper, we compare bank recapitalization against regulatory forbearance – not intervening or using only measures that do not address the undercapitalization problem directly. Japanese experience points at severe consequences of forbearance. Poorly capitalized banks tend to "evergreen" loans to insolvent firms (Peek and Rosengren 2005; Watanabe 2010). Because the

inefficient firms then do not exit their industries, more productive firms do not prosper, or may delay entry, which can lead to a long stagnation (Caballero, Hoshi, and Kashyap 2008). In contrast, Poland in the 1990s stands out as an example of a successful restructuring. Banks were recapitalized and incentivized to become agents of change in the restructuring of loss-making state owned enterprises. The ultimate privatization proceeds from the sale of banks and restructured firms, as well as bank capitalization ratios at the end of restructuring, far exceeded initial expectations (Van Wijnbergen 1997).

In addition to channeling credit to insolvent borrowers, weak banks impose another inefficiency by lending less to good borrowers. Chodorow-Reich (2014) documents this effect using a dataset on syndicated lending in the period before and after the Lehman collapse. Due to the stickiness of banking relationships firms, whose lead bank is weak, are not able to increase borrowing from other banks enough to offset lower borrowing from the weak bank. Consequently, those firms pay higher interest rates and reduce employment more. The distortions of zombie banks can be mitigated by recapitalizations. Mariathasan and Merrouche (2012) find that recapitalizations increase banks' propensity to lend. Similarly, Calomiris et al. (2013) find that recapitalizations increase bank lending. More specifically, they show that after the passage of Emergency Banking Relief Act in March 1933 (during the Great Depression) injections of preferred stock into distressed but not deeply insolvent banks increased their probability of survival and loan growth.

2 Model

We propose a simple theoretical model describing bad loans as a possible channel through which intervention could affect recession duration. In contrast to the existing literature on intervention, which focuses on the adverse selection problem (Diamond and Rajan 2011; Philippon and Schnabl 2013; Philippon and Skreta 2012; Tirole 2012) or on the ex ante moral hazard created by bailout expectations (Farhi and Tirole 2012), we analyze the ex post moral hazard

in lending that arises after a shock to bank assets. Our model is perhaps most closely related to a very early contribution to the literature on bank intervention, Berglof and Roland (1995), who investigate why the so called soft budget constraints emerge. Similarly as we do, they analyze bank incentives to refinance vs. liquidate loans to distressed borrowers. They and find that banks that have sufficient capital enforce discipline on borrowers and thereby induce effort in firms, while those with little capital refinance inefficient firms in order to benefit from a government bailout. Our analysis is also related to Spargoli (2012) who analyzes bank decisions to liquidate bad loans from a different perspective. Despite the lower payoff, banks tend to roll over bad loans in order not to reveal themselves as bad types to be able to borrow at a lower rate. Hiding loses and regulatory forbearance ultimately result in funding being allocated to inefficient projects and lower welfare. Core to our model is that the presence of nonperforming loans can give banks ample opportunities for risk shifting. Nonperforming loans can be very high in systemic banking crises. The average peak value of the ratio of NPLs to total banking assets during the 65 crises from the dataset of Laeven and Valencia (2012a) is 20%.[2] The model is set up to demonstrate how bank recapitalization improves incentives of a zombie bank and helps to motivate the subsequent empirical analysis. [3]

2.1 Timeline of events

There are two time periods. The first one lasts from $t=0$ until $t=1$ and the second from $t=1$ till $t=2$. There are three types of agents: a bank, depositors and the regulator. The regulator is only active from $t=1$ on if there is a banking crisis.

[2] The average value in crises before 2007 is 26%; in crises after 2007 it is 11%. The medians are 24% and 6.5%, respectively.

[3] Another channel for the effectiveness of intervention is related lending. La Porta, Lopez-de-Silanes, and Zamarripa (2003) examine related lending in the period following the Mexican crisis and find that related loans have more favorable borrowing terms, probability of repayment is lower and recovery rates are smaller than on loans to nonrelated parties. Their analysis also suggests that banks sharply increase the amount of related lending after being hit by a shock. The existence of related lending has been documented also in other countries (Laeven 2001; Johnson and Mitton 2003; Charumilind, Kali, and Wiwattanakantang 2006).

- At $t=0$ the bank raises k of equity and $1-k$ of debt with maturity of one period. It makes 1 unit of loans to firms that invest into two-period projects.
- At $t=1$ the bank and the regulator observe the quality of bank loans. A proportion of loans $1-q$ is good; the remaining q are bad loans. Depositors may withdraw. If the bank cannot obtain funding it liquidates the loans as much as necessary to repay depositors. The liquidation value of both good and bad loans is $\lambda<1$ per unit of a loan. If the bank can secure funding for the second period, it makes a decision about the bad loans. It either rolls them over as if they were good loans or liquidates them and lends the proceeds to new firms.
- At $t=2$ the bank collects loan repayments. Good loans repay a cash flow R with certainty. Bad loans that were liquidated and reinvested repay λR per unit of initial lending, with certainty. Bad loans that were not liquidated repay R with probability p and zero otherwise. Depositors are repaid. Bank shareholders get the residual.

[Figure 1 about here]

2.2 Depositors

Depositors are risk neutral and in expectation require a gross return equal to the risk free rate, which is normalized to 1. At $t=0$ the bank raises $1-k$ of deposits, for which it promises to repay D at $t=2$ or $\sqrt{D}$ at $t=1$ if depositors withdraw early. If they withdraw at $t=1$, the bank tries to raise new debt in the amount of $\sqrt{D}$ to repay the existing depositors. In case it cannot repay the promised amount, the depositors get all cash flows the bank can collect. If the bank is insolvent at $t=1$ the depositors get λ since the bank has to liquidate its entire loan portfolio. If the bank is insolvent at $t=2$, which can occur when bad loans did not perform well, the depositors get $R(1-q)$.

2.3 Bank

The bank pursues the interests of its shareholders. It is assumed that an incentive structure is in place that insures that the interests of bank managers do not diverge from those of bank shareholders. At $t=0$ bank shareholders pay in k of equity, on which they require an expected return strictly larger than the risk free rate. Assuming a premium on bank equity is consistent with the existing literature (Hellmann, Murdock, and Stiglitz 2000; Repullo 2004; Dell'Ariccia and Marquez 2006; Allen, Carletti, and Marquez 2009). The higher required return gives bank shareholders an incentive to lever up as much as possible. Bank shareholders are residual claimants on cash flows at $t=2$ and have limited liability. If the bank liquidates bad loans the payoff to bank shareholders is $R(1-q)+R\lambda q-D$.[4] If the bank rolls over bad loans, the payoff to bank shareholders is $R-D$ if the bad loans perform and zero if they do not.

2.4 Bad loans

By liquidating bad loans we mean a decision with which the bank sacrifices a part of the outstanding claim for a higher probability of being repaid. This can represent several decisions such as: (i) the use of the material adverse change clause, which gives a bank the right to call a loan when the probability of repayment deteriorates significantly; (ii) not rolling over a loan when the maturity of the loan is shorter than the duration of the project funded by the loan; (iii) restructuring of a loan where the bank writes off a part of the outstanding amount to increase the probability of repayment. Liquidation parameter λ is the amount that the bank can collect per unit of liquidated loans. It is socially optimal to liquidate bad loans. Leaving them as they are is risky and has a lower expected payoff than the payoff from liquidation (and new lending), which is certain.[5]

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[4] The payoff from liquidating bad loans is certain. Whenever the bank chooses to liquidate bad loans, this payoff has to be positive.

[5] The insights of the model would remain the same if good loans and new lending were risky but the variance of their repayment would be lower than the variance of bad loans that are rolled over.

$$pR < \lambda R \tag{1}$$

For simplicity it is assumed that the bank extracts all value from the firms to which it lends. The total amount collected from lending is then equal to the aggregate output. Despite the liquidation of bad loans being socially optimal, the bank may choose to roll them over if bank shareholders do not fully internalize the losses when bad loans fail. The bank chooses to liquidate bad loans if liquidation and subsequent lending to new firms brings a higher expected payoff to bank shareholders than does rolling over of bad loans. This is the case if (with $R_{roll\ over}$ being the outcome of rolled-over bad loans):

$$R(1-q)+R\lambda q \ > \mathrm{E}\left[\max\left(R_{roll\ over}-D,0\right)\right] \tag{2}$$

Computing the expected payoffs gives the liquidation incentive constraint: [6]

$$R\left(1-q\right)+R\lambda q-D > p\left(R-D\right) \tag{3}$$

If the liquidation incentive constraint (3) is not satisfied, the bank chooses to roll over bad loans.

2.5 Equilibrium in stable times

The lending rate R, the proportion of bad loans q, the liquidation value λ and the probability that bad loans repay p are public knowledge at $t=0$. The analysis focuses on the case where parameter values are such that banking is only viable if bad loans are liquidated in stable times. We therefore assume that if the bank holds on to bad loans the total expected return from lending is less than 1:

$$R\left(1-q\right)+Rpq<1<R\left(1-q\right)+R\lambda q \tag{4}$$

Thus depositors and bank shareholders can both earn at least the risk free rate only if bad loans are liquidated. Therefore in equilibrium bad loans have to be liquidated. If bad loans are liquidated,

[6] The incentive constraint only "bites" when debt obligations are so high that bank shareholders get zero in case bad loans fail. Note that for simplicity we assume that liquidation proceeds that are lent out again receive R with certainty. Assuming that a fraction q of those loans is likely to fail again makes no material difference to any of the results.

the loan repayments at $t=2$ are certain. Hence, with the risk free rate being equal to 1, the promised repayment to depositors is equal to their initial investment $D=1-k$. To insure that bad loans are liquidated, the incentive constraint (3) has to be satisfied. It can be expressed as a constraint on the bank capital ratio k.

$$k>1-\frac{R\left(1-p-q\left(1-\lambda\right)\right)}{1-p} \tag{5}$$

The only way for the bank to commit to liquidate bad loans is to have a sufficiently high capital ratio. Since bank shareholders require a return strictly larger than the risk free rate, they have an incentive to increase bank leverage as much as possible, so in equilibrium the incentive constraint is binding. The required capital ratio is increasing in the proportion of bad loans q and decreasing in the liquidation value λ.

2.6 Banking crisis

Our focus is on ex-post intervention so we model a banking crisis as a zero-probability event as in Allen and Gale (2000). A banking crisis differs from stable times in that the proportion of bad loans turns out to be unexpectedly high. Neither the bank nor the depositors expect a shock to the amount of bad loans, so at $t=0$ their behavior is exactly the same as in stable times. But at $t=1$ the bank (and the regulator) observe that the proportion of bad loans is $q+\xi$, with $\xi>0$ being the shock. It still is socially optimal to liquidate bad loans and lend to new firms. But the incentive constraint is no longer satisfied for the new, higher proportion of bad loans. The new capital ratio k' that would satisfy the incentive constraint given the higher proportion of bad loans, is larger than the existing capital ratio k:

$$\begin{aligned} k' &= 1-\frac{R\left(1-p-\left(q+\xi\right)\left(1-\lambda\right)\right)}{1-p} \\ &= 1-\frac{R\left(1-p-q\left(1-\lambda\right)\right)}{1-p}+\frac{R\xi(1-\lambda)}{1-p} \\ &> k \end{aligned} \tag{6}$$

Depositors recognize that the bank has been hit but do not observe the size of the shock. They cannot coordinate their actions. If all existing depositors withdraw, potential new depositors are not willing to lend to the bank either. Because the depositors do not know the size of the shock, a new deposit contract at a different rate is not feasible.[7] If the bank cannot obtain new deposits, it liquidates its loan portfolio at a rate λ to repay the existing deposits. If λ is less than the amount of debt $1-k$, depositors are not fully repaid. Whether $\lambda < 1-k$ depends on the equilibrium value of k; in what follows we will assume this to be the case.

The regulator, representing the central bank and the government, does observe the size of the shock. It cannot require the bank to liquidate bad loans but it can possibly improve total welfare by intervening the bank. Total welfare is defined as the sum of repayments to depositors, bank shareholders and the losses or gains realized by the regulator. In the absence of intervention, the entire bank is liquidated. The loans are then sold to outside investors. Depositors place the proceeds into riskless government securities. Total welfare is then equal to λ. This scenario implies efficiency losses because good loans are liquidated at a loss and because the proceeds from liquidation of loans are not lent on to new firms as the bank has gone out of business. Consider next two types of intervention, the first group directed at providing access to debt finance, and the second group focusing on recapitalization.

2.7 Deposit insurance, blanket guarantees and liquidity support

These measures prevent bank failures as the bank is able to obtain debt financing despite being insolvent. Because the incentive constraint is still not satisfied, the bank does not liquidate bad loans and gambles that they will succeed. Under deposit insurance or blanket guarantees on bank liabilities, the investors are willing to lend to the bank at the risk free rate because the regulator covers the difference between the value of bank assets $R\left(1-q-\xi\right)$ and the outstanding debt D in

[7] This assumption rules out equilibria where the deposit rate is adjusted for risk or where the bank shrinks. Such equilibria are only possible if the shock is small enough that bank shareholders can earn a positive return after readjustment.

case bad loans fail. The expected loss of the regulator is $(1-p)\left(D-R\left(1-q-\xi\right)\right)$. By providing liquidity support the regulator effectively substitutes all of the bank's existing debt. The expected repayment of the bank is $pD+(1-p)\left(R\left(1-q-\xi\right)\right)$. The expected loss to the regulator is exactly the same as under deposit insurance. Providing liquidity support or guaranteeing bank liabilities is a better outcome than the failure of the bank if the total expected repayment of the good loans and the bad loans that are rolled over is larger than the liquidation value of the entire bank, which is the case if:

$$pR+(1-p)R(1-q-\xi)>\lambda \tag{7}$$

If the amount of bad loans $q+\xi$ is too high (the shock too large), condition (7) is not satisfied and then guarantees on bank liabilities and liquidity support are worse than letting the bank fail at $t=1$.

2.8 Bank recapitalization

Bank shareholders do not have an incentive to recapitalize the bank at $t=1$ after it has been hit by a shock; recapitalization would only benefit the depositors. The regulator, however, can improve total welfare by recapitalizing the bank before the bank makes the decision about the bad loans. The incentive constraint of the bank can be satisfied if the regulator injects and amount of capital g into the bank, where g follows from:

$$k+g>1-\frac{R\left(1-p-q\left(1-\lambda\right)\right)}{1-p}+\frac{R\xi\left(1-\lambda\right)}{1-p} \tag{8}$$

The minimum amount of capital that satisfies this inequality is $\bar{g}=\frac{R\xi(1-\lambda)}{1-p}$. It is used to repay part of the existing deposits. Deposits in the second period are then only $1-k-g$. When the incentives for liquidating bad loans are restored, the value of bank assets at $t=2$ is $R(1-q-\xi)+R\lambda(q+\xi)$. This outcome maximizes total welfare for two reasons: (i) no good loans are liquidated (as would happen in the case of bank failure) and (ii) bad loans are liquidated (unlike

what happens under the other type of interventions). The regulator can recoup the costs of the equity injection at $t=2$. In terms of total welfare it does not matter whether the regulator recoups more or less than g at $t=2$.

The recapitalization that we focused on in the preceding analysis satisfies three conditions. First, the recapitalization has to be done before the bank makes the decision about bad loans. If it is done after the bank has already rolled over the bad loans, it has no beneficiary effect on incentives: ex post recapitalization only covers the losses from failed bad loans. Second, the recapitalization needs to be large enough. We assume that the regulator cannot take over the bank and thus cannot directly instruct the manager to liquidate bad loans. Therefore the recapitalization has to be high enough so that with $k+g$ of equity, liquidation of bad loans becomes in the interest of bank shareholders. Third, there should be a ban on dividend payouts. If existing bank shareholders could decide what to do with recapitalization funds they would prefer an immediate payout and a continued gamble with the bad loans. To be effective, the recapitalization has to reduce leverage enough to shift incentives, so it should be accompanied by a ban on dividend payments.

2.9 Model summary and empirical predictions

We can summarize the model as follows. A bad loan is a highly risky project with an expected payoff lower than its liquidation value. Yet, it is attractive for a weakly capitalized bank: due to the limited liability the bank's shareholders capture the upside if the bad loans repays but shift the risk of losses to debtholders. On the aggregate level renewing bad loans results in lower output because inefficient firms are funded instead of productive new or expanding firms. In stable times, depositors correctly predict the proportion of bad loans that banks will realize. In equilibrium bank leverage is then such that banks have an incentive to liquidate bad loans. But in a banking crisis the ratio of bad loans turns out to be unexpectedly high. Banks that have been hit no longer have an incentive to liquidate bad loans. If depositors expect a bank to be insolvent in the final period,

they withdraw early causing the liquidation of the bank. If the bank is liquidated, there are efficiency losses as together with bad also good loans are liquidated. The regulator can improve welfare if it prevents bank failures and restores incentives of banks to liquidate bad loans. Recapitalizing banks before they make a decision about bad loans fulfills both objectives. Providing liquidity support or guaranteeing bank liabilities, however, only prevents bank failures but does not change their incentives for managing bad loans. The empirical prediction from the model is that bank recapitalizations improve welfare, which in our empirical analysis translates into shorter recession duration.

3 Empirical methodology

Our dataset is a panel of systemic banking crises where index i denotes a crisis and t refers to a particular quarter of a recession. For each crisis i the sample includes all quarters when the country was in a recession and the quarter when it recovered. The time index t indicates how many quarters a recession has already lasted. In the first recession quarter it is $t=0$ at the time of recovery it is $t=T_i$; the completed recession duration of a crisis i is T_i. For each observation in the sample recession indicator y_{it} indicates whether a country is in a recession or it has just recovered.

$$y_{it}=\begin{cases}1 & \text{recession ends}\\ 0 & \text{recession is ongoing}\end{cases}$$

In regressions we estimate the effect of intervention on the probability of recovery, which is in the context of a duration model called the hazard rate $\lambda(t,x_{it},c_i)$. Explanatory variables that are positively related to the hazard rate, increase the probability of recovery and reduce the expected duration. The hazard rate is conditional on that the recession has not ended before quarter t, on the values of explanatory variables x_{it}, and the unobserved heterogeneity c_i.[8]

[8] For additional discussion on modeling duration of a process see Online Appendix A. Modeling duration of a process, available at http://www.uva.nl/profile/t.homar.

$$\lambda(t, x_{it}, c_i) = \Pr(y_{it} = 1 \mid y_{it-1} = 0, ..., y_{i1} = 0, x_{it}, c_i) = G(x_{it}\beta + \gamma_t + c_i) \quad (9)$$

$G(\cdot)$ is a cumulative distribution function that maps the expression $x_{it}\beta + \gamma_t + c_i + e_{it}$ into a probability measure. Crisis severity has two components: a time-varying component $\gamma_t = \gamma(t)$, which is a function of elapsed duration and crisis-specific fixed effect c_i. The time-varying component captures the pattern that the probability of recovery follows over time independent of intervention. We expect it to be an increasing function of time (but not necessarily monotonically increasing). Intervention is likely to be correlated to crisis severity. We model this correlation by assuming that the component c_i of crisis severity is a function of the average values of intervention variables over the quarters of a recession.

$$c_i = \psi + \bar{x}_i \delta + v_i \quad (10)$$

Error term v_i is assumed to be normally distributed, δ is a vector of coefficients describing the relationship to average intervention and ψ is a constant. This specification can capture correlation between severity and intervention when either a particular type of intervention is more likely to be used in severe than in mild crisis or when the quantity of intervention depends on the severity. In all these cases the average value of intervention in a crisis is informative about crisis severity. Our identification is based on the part of variation in intervention that is not correlated to c_i, thus the variation in intervention over time within a recession.

We use the approach proposed by Mundlak (1978) to incorporate this form of crisis severity into the estimation equation. First we restate equation (9) using y_{it} as an indicator of the latent probability of recovery $y_{it} = 1[y_{it}^* > 0]$ in place of the hazard rate ($1[....]$ is an index function that equals 1 if $y_{it}^* > 0$ and 0 otherwise).

$$y_{it}^* = x_{it}\beta + \gamma_t + c_i + e_{it} \quad (11)$$

Then we combine it with equation (10), which describes the relationship between policies and crisis severity to obtain the estimation equation:

$$y_{it}^{*} = x_{it}\beta + \bar{x}_i\delta + \gamma_t + v_i + e_{it} \,. \tag{12}$$

The constant ψ from equation (10) drops out as a constant is already included in γ_t for which we use a cubic function $\gamma_t = \gamma_0 + \gamma_1 t + \gamma_2 t^2 + \gamma_3 t^3$. Specification (12) can be estimated also with nonlinear methods such as complementary log-log or logit. Another advantage is that it allows us to test whether correlation between explanatory variables and unobserved heterogeneity is in fact an issue. If the estimate of the coefficient vector δ in (12) is not significant, the correlation between explanatory variables is not problematic and a specification without $\bar{x}_i$ as a regressor can be estimated.

Based on the estimated parameters from equation (12) we can calculate predicted probabilities of recovery, which we then use to obtain expected recession durations. Bellow we provide equations for predicted probabilities for three estimation models that differ in terms of distributional assumption: the complementary log-log model, the logit model and the linear probability model. A desirable characteristic of the complementary log-log model is that it assumes that the underlying process (recession) is continuous but can only be observed at discrete points in time, while the logit or the linear probability model require the assumption that the duration process is discrete. Therefore we use the complementary log-log specification as our basic approach[9]. The predicted probability of recovery in period *t* conditional on the recession not having ended in any of the previous quarters and conditional on x_{it} and c_i is given by the following equations for the complementary log-log (13), the logit (14) and the linear probability (15) model respectively:

$$\hat{P}\left(y_{it} = 1 \mid y_{it-1} = 0, \ldots, y_{i1} = 0, x_{it}, c_i\right) = 1 - \exp\left(-\exp\left(x_{it}\hat{\beta} + \bar{x}_i\hat{\delta} + \hat{\gamma}_t\right)\right) \tag{13}$$

[9] In robustness checks we report estimates based on the other two probability models. It is clear from that table that using alternative probability models does not materially change any of the results.

$$\hat{P}\left(y_{it}=1 \mid y_{it-1}=0,\ldots,y_{i1}=0,x_{it},c_i\right)=\frac{\exp\left(x_{it}\hat{\beta}+\bar{x}_i\hat{\delta}+\hat{\gamma}_t\right)}{1+\exp\left(x_{it}\hat{\beta}+\bar{x}_i\hat{\delta}+\hat{\gamma}_t\right)} \tag{14}$$

$$\hat{P}\left(y_{it}=1 \mid y_{it-1}=0,\ldots,y_{i1}=0,x_{it},c_i\right)=x_{it}\hat{\beta}+\bar{x}_i\hat{\delta}+\hat{\gamma}_t \tag{15}$$

These probabilities are from here on referred to as conditional probabilities of recovery. In contrast, the term unconditional probability of recovery is used for the predicted probability of recovery that is conditioned only on the values of explanatory variables until then $X_{i\{1,\ldots,t\}}$ and c_i but not on the recession not having ended before. The unconditional probability of recovery is the product of the probability of recovery conditional on recession lasting until t and the unconditional probability that the recession has not ended in the previous quarter.

$$P\left(y_{it}=1 \mid X_{i\{1,\ldots,t\}},c_i\right)=P\left(y_{it}=1 \mid y_{it-1}=0,\ldots,y_{i1}=0,x_{it},c_i\right)\cdot\left(1-P\left(y_{it-1}=1 \mid X_{i\{1,\ldots,t-1\}},c_i\right)\right) \tag{16}$$

The unconditional probability that the recession has not ended in the previous quarter can be expressed as the corresponding conditional probability of that quarter (conditional on the recession not having ended the quarter before) and the unconditional probability of no recovery a quarter before. This procedure can be repeated all the way back to the first quarter when the conditional probability of recovery is equal to the unconditional probability as there is no preceding quarter. This gives an expression for the unconditional probability of recovery in quarter t as a product of conditional probabilities of no recovery in all previous quarters.

$$\begin{aligned}P\left(y_{it}=1 \mid X_{i\{1,\ldots,t\}},c_i\right)=&P\left(y_{it}=1 \mid y_{it-1}=0,\ldots,y_{i1}=0,x_{it},c_i\right)\cdot\\&\cdot\left(1-P\left(y_{it-1}=1 \mid y_{it-2}=0,\ldots,y_{i1}=0,x_{it-1},c_i\right)\right)\cdot\ldots\cdot\left(1-P\left(y_{i1}=1 \mid x_{i1},c_i\right)\right)\end{aligned} \tag{17}$$

The expected recession duration $E\left[T_i\right]$ is the product of the predicted unconditional probabilities of recovery in any period and their respective durations, which range from $t=0$ up to $t=t_{MAX}$.

$$E\left[T_i\right]=\sum_{t=1}^{t_{MAX}}\left[t\cdot\hat{P}\left(y_{it}=1 \mid x_{i\{1,\ldots,t\}},c_i\right)\right] \tag{18}$$

The limit t_{MAX} is set at a value where the numerically computed probability of recession lasting until then is equal to zero.

4 Data

The dataset covers 68 systemic banking crises from the period 1980 to 2013, of which 40 are from the period before 2007 and 28 belong to the recent global financial crisis. For each banking crisis the panel includes the quarters in which a country was in a recession, and the quarter when it recovered.[10] We start with the list of 65 systemic banking crises described by Laeven and Valencia (2012b). They consider a banking crisis to be systemic if two conditions are met. Firstly, there is major distress in the banking system such as bank runs, large losses of bank capital and bank liquidations. Secondly, there need to be significant policy interventions in response to the problems in the banking sector. This condition is met if at least 3 of the following measures were used:

- extensive liquidity support (claims of the central bank on deposit money banks larger than 5 percent of deposits and liabilities to nonresidents);
- gross bank restructuring costs at least 3 percent of GDP;
- significant bank nationalizations;
- significant guarantees on bank liabilities;
- asset purchases amounting to at least 5 percent of GDP;
- deposit freezes or bank holidays.

When both conditions are met a crisis is considered systemic. If just 2 types of measures from the list above were used, Laeven and Valencia (2012b) report it as a borderline case. All crises in the 1980 to 2006 period listed in their dataset were systemic according to the above definition. In the

[10] Exceptions are Cyprus and the second crisis in Greece where the recessions were still ongoing in 2013 Q3, which was the last available observation. For these two crises the sample includes only recessionary quarters and no recovery quarter.

recent global financial crisis 17 countries were classified as having a systemic banking crisis and 8 as borderline cases. The starting date of a banking crisis is the quarter in which major distress in the banking sector was observed. The date when a crisis becomes systemic is the quarter when the above conditions are fulfilled. Using these criteria, we add 3 more crisis to the list: Cyprus starting in 2011 Q3, Greece 2010 Q2 and Spain 2011 Q3. Greece and Spain already experienced a banking crisis in 2008 Q3. The recessions immediately following the 2008 crisis had already ended by the time problems in the banking sector reemerged. We analyze the first and the second crises of these two countries separately as there were two recessions and multiple rounds of intervention measures during both recessions. Table 1 lists the systemic banking crises from the period 1980 to 2006. Countries that experienced a systemic banking crisis (or were classified as a borderline case) during the recent global financial crisis are listed in Table 2. Some banking crises were not followed by a recession. These crises are included in the tables although they cannot be analyzed with recession duration models. In total there are 13 such crises, 11 in the period before 2007 and 2 after. Next we describe the variables used in the regression analysis.

[Table 1 about here]

[Table 2 about here]

4.1 The Recession indicator

The recession indicator is the dependent variable in the duration models. It is equal to 0 if a country is in a recession in a given quarter and equal to 1 if it has just recovered from it. For countries that are not in a recession at the time of the banking crisis start, the start of the recession is defined as the first quarter with negative GDP growth after the start of the banking crisis. This quarter needs to be either part of a sequence of at least two consecutive negative growth quarters or a sequence of positive and negative quarters where a positive quarter is always preceded and

succeeded by a negative quarter and there are at least two consecutive negative quarters in that sequence. The recession needs to start at latest 6 quarters after the start of a banking crisis to be considered related to the banking crisis.[11] Two consecutive positive growth quarters mark the end of a recession. The first of these two quarters is the recovery quarter in which the recession indicator turns 1. The recession period is composed of quarters with negative growth but may include few positive growth quarters within the sequence of negative growth quarters.[12] Such a definition is used as one positive growth quarter does not mean that a recession is really over. Applying this definition to determine the start and end of the recent recession in the US gives the same dates as the ones announced by the National Bureau of Economic Research. NBER (2012) uses multiple indicators and judgment to define the date of a peak and a through. A recession is the period between a peak and a through. The recent recession in the US began with the peak in December 2007 and ended with the through in June 2009. In the first quarter of 2008 GDP growth was negative; in the second it was positive; then four quarters of negative growth followed. The recovery quarter was the third quarter of 2009. Some countries are already in a recession in the quarter when the banking crisis starts. In these cases the negative growth quarters before the start of the banking crisis are counted as a part of the recession.[13] The sources of GDP data are the World Economic Outlook and the International Financial Statistics databases (IMF 2013a; IMF 2013b).[14]

[11] The recession in Cote d'Ivoire started 2 years after the start of the banking crisis. The primary reason of this recession was not the banking crisis therefore we do not include it into the sample. All other recessions started at latest 5 quarter after the banking crisis start.

[12] In the robustness section we estimate the model using a definition where only consecutive negative growth quarters are counted as a recession, with similar results.

[13] Only the consecutive negative growth quarters that run up to the start of the banking crisis are counted as an existing recession. The pre-banking crisis period with alternating growth rates is not counted as a recession.

[14] For more details about the data see Online Appendix B. GDP data sources, available at http://www.uva.nl/profile/t.homar.

4.2 Bank recapitalizations

The variable bank recapitalizations measures the cumulative amount of recapitalizations in the banking sector since the start of the crisis. The amounts are weighed by total assets of the banking sector. Recapitalizations are assumed to have an effect on the probability of recovery from the first quarter after they have been implemented until the end of the recession.

There is a variety of measures that could be considered a recapitalization. We count as recapitalization injections of common equity, preferred stock, conditionally convertible bonds or any Tier 1 qualifying instrument by the state, a bank restructuring agency or other government agency. We do not consider injections of subordinated debt, qualifying as Tier 2 capital, a recapitalization. Conversion of subordinated debt or other bank liabilities into equity and liability management exercises are counted as recapitalization. Write-offs of bank liabilities in the process of bank restructuring where creditors do not get any security in exchange are not counted as recapitalization although they are sometimes referred to as the contribution of bondholders toward recapitalization. In purchase and assumption deals the state often compensates the acquiring bank for the difference between the value of assets and liabilities of the bank that is being taken over in the process of restructuring. This amount is not counted as recapitalization as it merely brings the net asset value of the restructured bank to zero. It benefits the creditors of the distressed bank that would otherwise suffer losses in the process of restructuring and does not increase capital of the acquirer. If the acquiring bank receives an equity injection on top of that, the equity injection is counted as recapitalization. Sometimes both the state and private investors participate in bank equity issues. In those cases only the amount purchased by the state is counted as recapitalization.

We collect the data about bank recapitalizations from four types of sources: IMF staff reports, European Commission decisions about state aid, webpages of central banks, restructuring agencies and annual reports of intervened banks.

We need the total amount of recapitalizations in the banking sector in each quarter for all crises. Whenever possible we collect the recapitalization amounts at bank level. We document the

amount of recapitalization, a description of the measure and the month or quarter when the measure was implemented. For the recent crises almost all data has this level of detail. If bank-level data is not available, we collect data about total amount of recapitalizations in each quarter of a recession. For some crises before 2007 IMF staff reports only include how much was spent on recapitalizations until a certain date. In such cases we use two rules how to allocate the amounts across the quarters. If the names of banks or the number of banks intervened in a particular quarter are reported but not the amounts per bank, we assume that each of the intervened bank received an equal amount. If only the date when a bank restructuring program was approved by the government and the total amount of recapitalizations at a later point in time are known, we assume that recapitalization amounts are evenly spread across quarters between the start of the restructuring program and the time at which the cumulative amount of recapitalizations is reported. Table 1 and Table 2 provide data about the amount of bank recapitalizations in banking crises. [15]

In some regressions we use an indicator for bank recapitalizations, which turns from 0 to 1 in the quarter after the following two conditions are satisfied:

- The cumulative recapitalizations since the start of the crisis exceed half of the amount of recapitalizations in the whole banking crisis (which includes recapitalizations after the recession has already ended).
- The cumulative recapitalizations exceed the threshold to be considered significant. This limit is 0.75% of total banking assets for 2007 to 2013 crises and 1.75% of total banking assets for 1980 to 2006 crises. It is 50% of the median total amount of recapitalizations in banking crises where there were some recapitalizations.

[15] We plan to make the detailed data about bank recapitalizations publicly available. For now the data is available upon request.

The first condition is to determine the time when the main part of bank recapitalizations has been implemented. The second is necessary not to treat crises with very little recapitalizations as having done a proper bank restructuring.

4.3 Guarantees on bank liabilities

We use an indicator for the presence of significant guarantees on bank liabilities other than deposits. The indicator takes value 1 if guarantees were present in the preceding quarter. The lag is used in order to allow some time for the guarantees to have an effect on GDP growth. We use the data of Laeven and Valencia (2012b) about the introduction and removal dates of significant guarantees on bank liabilities and complement it with data from European Commission decisions about state aid. The indicator for guarantees on bank liabilities in quarter t is equal to 1 if the guarantees were in place in the preceding quarter. The lag is used in order to allow some time for the guarantees to have an effect on GDP growth. The variable values are based on the dates of introduction of blanket guarantees and dates of removal reported in (Laeven and Valencia 2012) and documents of the European Commission about state aid decisions where the guarantee schemes requested by member states are approved.[16]

4.4 Liquidity support, monetary and fiscal policy

The measure for liquidity support provided by central banks is the ratio of claims of monetary authorities on deposit money banks to total deposits, computed from end of quarter values lagged by one period. For monetary policy, we use two alternative measures. The preferred proxy, available for crises after 2007, is the decrease in real interest rates from quarter $t-2$ to $t-1$ (when the probability of recovery in quarter t is analyzed). In the analysis of crises before 2007 and of the full sample we employ the quarterly growth rate in reserve money as a proxy for

[16] For details see Online Appendix C. Data about guarantees on bank liabilities, available at http://www.uva.nl/profile/t.homar.

monetary policy not to lose observations because interest rate data is not available for all pre-2007 crises. We control for the effect of fiscal policy by using the cyclically adjusted general government deficit, which is available for most of the crises after 2007 but very few crises before 2007. The source of data for liquidity support and monetary policy is the International Financial Statistics database (IMF 2013b) and for fiscal policy the World Economic Outlook Database (IMF 2013a).[17]

5 Results

We estimate the effect of bank recapitalizations, guarantees on bank liabilities, liquidity support, monetary policy and fiscal policy on the probability of recovery from recessions related to banking crises. The dependent variable is the recession indicator, having value 0 if a country is in a recession and value 1 if it has just recovered from a recession. The explanatory variables in the regressions are of three types. First, there are the variables representing policies used in banking crises. A positive estimated coefficient means that a higher value of the explanatory variable increases the probability of recovery. Second, there are averages of intervention variables, averaged over all time periods of a recession to control for the correlation between crisis severity and intervention. Third, a linear, quadratic and cubic term of elapsed duration are included to flexibly account for the possibility that the probability of recovery depends on how long a recession has already lasted.

[Table 3 about here]

Table 3 reports the results estimated on three samples: the full sample of systemic banking crises from 1980 until 2013, and separately for the subsample of past crises from the period 1980 to 2006 and the subsample of recent crises. The samples include crises in which the recession

[17] For details see Online Appendix D. Data about liquidity support, monetary policy and fiscal policy, available at http://www.uva.nl/profile/t.homar.

began up to 2 quarters before the start of the banking crisis. The start of the banking crisis is defined as the quarter when major distress in the banking sector was observed. Crises that did not have a recession or crises where the country was already in a recession for more than 2 quarters before the banking crises started, are not included. This cutoff is used to exclude recessions where the problems in the banking system are not an important determinant of the probability of recovery for a large part of recession duration. In Section 6 below, where we check the results for robustness, we present alternative specifications that also include crises with long recessions before the banking crises. This does not affect the results materially.

The estimates of the effect of bank recapitalizations on the probability of recovery are positive and significant in all samples: bank recapitalizations significantly increase the probability of recovery. Guarantees on bank liabilities on the other hand do not have a significant effect, while liquidity support is marginally (at a 10% level) significant only in the full sample; in both subsamples separately it is insignificant. The estimates for growth of reserve money are negative and insignificant. We use growth in reserve money as a proxy of monetary policy in order to be able to perform the analysis on the maximum possible number of crises. However, when we substitute it with the reduction in real interest rates in column (4), the estimated effect is positive and significant, albeit only marginally so, at 10%. The effect of fiscal policy approximated by the cyclically adjusted fiscal deficit is not significant.

Coefficients of *averages* of bank recapitalizations, guarantees on bank liabilities and real interest rate reduction are statistically significant for at least one sample. This confirms that policies are correlated to unobserved heterogeneity hence including their per crisis average values is necessary to obtain consistent estimates of the coefficients of interest. Time dependence seems to be stronger and more significant in past crises than in recent crises. The coefficient of the linear duration is positive, so the longer a recession has already lasted, the more likely it is to end in the current quarter. The quadratic term is negative, so the marginal effect of duration on exit probability decreases as crises last longer. In other words, recessions that have already lasted some

time are likely to be long, so the probability of recovery is decreasing in the square of the duration (the marginal effect decreases linearly in crisis severity). But every recession ends at some point, so the effect of the cubic term is positive.

In many crises, recapitalizations are done at multiple times but with the largest amounts typically concentrated in one quarter. To approximate this we rerun the regressions with an alternative definition of bank recapitalization: we replace the continuous recapitalization variable with the bank recapitalization indicator, which loosely speaking equals one when a significant bank recapitalization took place; for a more precise definition see Section 4. If there were only minor recapitalizations, the value of the indicator is zero. Table 4 reports the results of the regressions of Table 3 but performed with the indicator instead of the continuous bank recapitalization variable.

[Table 4 about here]

The basic results are again confirmed: bank recapitalizations are the intervention with the most significant effect. To investigate the size of their effect on recession duration, we compute expected recession durations for two representative crises: a crisis representing the group of crises where substantial recapitalizations were done and a crisis representing the group with no or very little recapitalizations. The reason for introducing two representative crises is that the two groups of crises differ in unobserved crisis severity. Banking crises where banks were recapitalized tended to be much more severe than those where recapitalizations were not done. We use the expression *severe representative crisis* to denote the representative crisis of the group with significant bank recapitalizations and *mild representative crisis* to refer to the representative crisis of the group with no or minor recapitalizations. We compute expected recession duration with and without bank recapitalization for both representative crises. The expected durations are computed using equations (13), (17) and (18). The inputs for conditional probabilities of recovery are the estimated coefficients from Table 4 and the values of explanatory variables of the two representative crises.

The explanatory variable values of the severe (mild) representative crisis are simply the averages of explanatory variables of crises where bank recapitalizations were (were not) done. The only explanatory variables of representative crises that are not averages and are not constant in all time periods of a representative crisis are the elapsed duration, which increases every quarter, and bank recapitalization indicator which changes from 0 to 1 in the quarter after bank recapitalization is done. The median time that the recession has already lasted when bank recapitalizations were done is 1 quarter in the past crises and 2 quarters in the recent crises. When computing the expected durations we assume that bank recapitalization is done at $t = 2$ and has an effect on the probability of recovery from $t = 3$ onwards.

We emphasize that the explanatory variable average of bank recapitalization indicator (not to be confused with the bank recapitalization indicator), is by definition constant over all time periods. This enables us to analyze the effect of bank recapitalization independent from crisis severity by changing the value of the bank recapitalization indicator while keeping the component correlated to crisis severity fixed. For the mild representative crisis the value of this component is equal to 0 in all time periods. For the severe representative crisis the value of the component is positive.

[Table 5 about here]

Table 5 reports the expected durations computed based on estimates from Table 4. Column (1) of Table 5 refers to column (1) of Table 4 etc. The size of the effect of bank recapitalization becomes apparent when the expected recession durations are compared. For the sample of 2007 to 2013 crises in column (4) the expected duration of severe representative crisis with bank recapitalization is fairly close to the average observed duration of severe crises; similarly the average observed duration of mild crises is close to the expected recession duration of the mild representative crises if bank recapitalization is not done. So our benchmarks seem well chosen.

The counterfactual durations, however, are very different. The severe representative crisis would last 11 quarters instead of 6.3 quarters if bank recapitalization would not have been done. The expected recession of the mild representative crisis is reduced from 5.6 to 3.5 quarters if bank recapitalization is done. So on average bank recapitalization reduces expected recession duration by about 40%.

Another way of translating the regression results into an understandable metric is a comparison of exit probabilities over time with and without recapitalizations. Once again we do this for severe and mild crises, as defined earlier. We plot the predicted conditional probabilities, the same that were used to compute expected durations for past crises in column (2) and for the recent crises in column (4) of Table 5. We present the graphs of subsamples separately.[18] In the plots below we show the predicted exit probabilities with and without intervention.

[Figure 2 about here]

[Figure 3 about here]

[Figure 4 about here]

[Figure 5 about here]

Initially, when a recession starts at $t = 0$, the predicted probability of recovery is very low, then it gradually increases as time goes by. At some point the curve flattens or even slightly

[18] The reason is that the estimates on the sample of recent crises with real interest rates and fiscal policy are preferable. Also according to the likelihood ratio test pooling of the two subsamples should not be done. We test whether the null-hypothesis that the estimates on the full sample in column (1) of Table 3 (or Table 4) are not significantly different from the estimates on the subsamples in columns (2) and (3). The test statistic is $D = -2 \ln L_{Full\ sample} + 2 \ln L_{Past\ crises} + 2 \ln L_{Recent\ crises}$; degrees of freedom are equal to the number of constraints, which equals the number of explanatory variables. The *p*-value of the test with estimates from Table 3 is 0.0122 and with those from Table 4 it is 0.0667. Thus regressions should be run on the two subsamples separately.

decreases (the 1980 to 2006 representative crises), but eventually it approaches 1: even without intervention, recessions at some point come to an end. The shape of the curve is due to time dependence, which is captured by the duration terms in regression specification (12). We implement the bank recapitalization at $t = 2$, which explains the jumps in the plots at $t = 3$.[19] In the absence of intervention the initial shock that caused the banking crisis and time dependence determines the time pattern of exit probabilities and the expected duration as becomes clear by comparing the no-intervention exit probabilities in the plots for the mild and the severe crisis respectively. The exit probabilities derived from the estimates based on the more recent subsample give qualitatively similar results: both for severe and mild crises, bank recapitalization significantly reduces expected recession durations (Figure 4 and Figure 5). The plots demonstrate our earlier results very clearly: bank recapitalizations increase the probability of recovery substantially.

[Table 6 about here]

Finally, we investigate possible *interaction effects* between bank recapitalizations and other policies on the sample of recent crises. The results are reported in Table 6. When interactions terms are included individually, the interaction of guarantees on bank liabilities with bank recapitalizations and fiscal policy with bank recapitalizations are negative and significant. However, when all interaction terms are included simultaneously, their signs do not change but significance levels are much reduced, in fact no interaction term is significant in column (6) of Table 6. In all variants the basic impact of bank recapitalizations remains highly significant. The significance level of real interest rate reduction increases compared to the baseline regression.

Guarantees on bank liabilities were used in all but one crisis after 2007. They were almost always already in place when bank recapitalizations were done. The negative interaction coefficient

[19] The absolute difference in the probability of recovery with and without bank recapitalization is widening also after $t = 3$ although then there is no change in policy anymore. The reason is that the change of bank recapitalization indicator happens within the cumulative distribution function so the shift in the predicted probability is not linear.

suggests that guarantees have a more positive (although still insignificant) effect in the first phase of the crisis before bank recapitalizations are done but that their effect goes down once recapitalizations are implemented. The negative interaction term with fiscal policy is consistent with the predictions of Van der Kwaak and Van Wijnbergen (2013), who argue that fiscal stimuli in a weak bank capitalization environment are less effective than the same stimuli would have been if banks would have been better capitalized. Since bank recapitalizations are more likely when banks are more undercapitalized, the negative coefficient of the interaction term suggests that fiscal policy is less effective in a weak banks environment, in line with their theoretical results.

6 Robustness checks

In this section we perform several additional regressions to check the robustness of our results. Firstly, we include the squared term of bank recapitalizations into the regression specification to check whether each additional amount of recapitalizations is equally beneficial. We find an insignificant positive effect of the squared term on the sample of past crises and a negative effect on the sample of recent crisis. The significance of this effect is, however, driven by one single crisis, Cyprus. The crisis in Cyprus is special in two respects. The recession was still ongoing at the time of our data collection (2013 Q3) and the amount of recapitalizations (17.86% of total banking assets) is an outlier in the 2007-2013 sample. Similarly as Cyprus also the second Greek recession, which started in 2010 Q1 was not yet finished by 2013 Q3.

[Table 7 about here]

Table 7 reports four regressions with which we investigate the negative effect of squared recapitalization. In column (1) Cyprus as well as all other crises in 2007 to 2013 period are included. The estimated effect of the squared term is negative and highly significant. In column (2) Cyprus is excluded. The effect of squared recapitalizations becomes insignificant. In column (3) also the

second Greek recession is included, which does not make any difference compared to column (2). In column (4) we use forecast data for the second Greek recession (and do not include Cyprus). The forecasts from the World Economic Outlook database (IMF 2013a) predict that Greece will recover in 2014 Q1. In addition to that we assume that the values of policy variables will be the same in 2013 Q4 and 2014 Q1 as in 2013 Q3.[20] The estimation results in columns (2), (3) and (4) are very similar; the squared term of bank recapitalizations is always insignificant. Based on this results we conclude that the negative effect of squared recapitalizations is due to Cyprus. A possible interpretation for the negative effect could be that bank recapitalizations that are very large are large not because the government wanted to bring banks to a higher capitalization level than when recapitalizations are intermediate but because the recapitalizations were delayed for too long. The zombie banks are already deeply insolvent when they are recapitalized. In such circumstances it can be that each additional unit of recapitalization is not as effective as when the scale of problems in the banking sector is smaller. But because this result only depends on one crisis we do not include Cyprus and the squared recapitalizations in the main results in the previous section.

[Table 8 about here]

To check whether our results are robust with respect to the definition of recession duration we reestimate the results using either a laxer or a stricter rule to determine which quarters constitute a recession, than in the main results. Under the lax definition we do not require a recession to include two consecutive negative growth quarters; a sequence of a negative, a positive and a negative quarter would now also be considered a recession.[21] In addition to this change we include also recessions that started more than 2 quarters before the start of the banking crises. As these

[20] Our data about policy variables runs until 2013 Q2 but because the values of policy variables are lagged in regression we in fact can use actual data until 2013 Q3 and only need to use assumptions for two quarters.

[21] Under this definition Bolivia had a recession, while it did not have one under the main definition.

recessions were not related to a banking crisis when they started we only count 4 quarters before the start of the banking crisis and the quarters after the start of the banking crisis as their recession duration. This adds 2 more recessions to the sample.[22] Under the strict definition we only count consecutive negative quarters as recession and do not include recessions that started more than 2 quarter before the banking crisis. Compared to the main definition some recessions are shorter under this definition. They either start later or end sooner. Table 8 provides the estimation results with both recession definitions. The estimates in columns (1) and (4) on the full sample can be compared with column (1) of Table 3, columns (2) and (4) on the sample of past crises with column (2) of Table 3, and columns (3) and (6) on the sample of recent crises with column (4) in Table 3. The estimation results under both alternative definitions are very similar to the main results. The effect of bank recapitalizations and reduction in real interest rate are positive and significant. The estimated effect of liquidity support is positive under the lax definition of recession for the sample of past crises while it was insignificant in the main results and the negative effect of guarantees becomes significant under the strict recession definition on the past crises sample. Otherwise there are no important differences.

[Table 9 about here]

In the final robustness check we run the regression using different distribution functions for the duration model. Instead of complementary log-log random effects estimation we use either logit random effect estimation or linear probability model with random effects. Table 9 reports the results. The estimates obtained with logit are very similar to our main results in Table 3. In the

[22] Under this definition the recession in Bulgaria is assumed to start in 1995 Q1, and in Uruguay in 2002 Q1. Two other crises with long recessions before the start of the banking crisis, Argentina 1989 and Finland 1991 cannot be included as they have missing data for one of the policies.

linear probability model the predicted probabilities can lie outside of the [0,1] range but even then the effect of bank recapitalizations remains.

7 Conclusions

In this paper we ask the question: how costly is regulatory forbearance that allows zombie banks to continue to operate? More specifically, how much longer will a recession last if distressed banks are not recapitalized? We analyze recessions after 68 systemic banking crises in the period from 1980 to 2013. Our approach takes into account that intervention in banking crises is endogenous to crisis severity. We estimate a duration model with crisis-specific fixed effects, allowing for the possibility that the average level of intervention over the crisis period is correlated to unobservable crisis severity. We find a positive and highly significant effect of bank recapitalizations on the probability of recovery. We do not find such support for the effectiveness of guarantees on bank liabilities or liquidity support. For the purpose of addressing the undercapitalization problem these policies are inferior to bank recapitalizations.

The theoretical part of our paper offers a potential explanation of these results. We model a channel through which intervention measures could affect aggregate output. Undercapitalized banks have incentives to roll over loans to distressed borrowers instead of restructuring or liquidating them. In that way zombie banks form a drag on economic recovery. They continue funding inefficient firms and ration credit to new borrowers with good projects. Bank recapitalizations can mitigate these adverse incentives and hence shorten recessions. Other intervention measures such as guarantees on bank liabilities and liquidity support are not as effective because they do not address the perverse incentives coming from undercapitalization.

We compute expected recession durations at different values of intervention variables while keeping crisis severity constant. The results clearly show that bank recapitalizations substantially reduce expected recession duration. Looking at actual durations, one finds, however, that crises where bank recapitalizations took place have a similar duration as those crises where no

recapitalization was done. In both cases the average duration is about 5 quarters. But this is a false comparison. A typical crisis where banks were not recapitalized would have lasted only 3 quarters with recapitalization, while a crisis where banks were recapitalized would have had a recession duration of 11 quarters without recapitalization.

Our findings show that recapitalizing banks is an effective intervention from the ex post perspective. If also the ex ante perspective is considered, a number of interesting questions can be raised. What is the tradeoff between the ex post optimal intervention and banks' ex ante incentives that anticipate such intervention? What role do (ex ante) capital requirements play? We leave this questions for future research.

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FIGURES AND TABLES

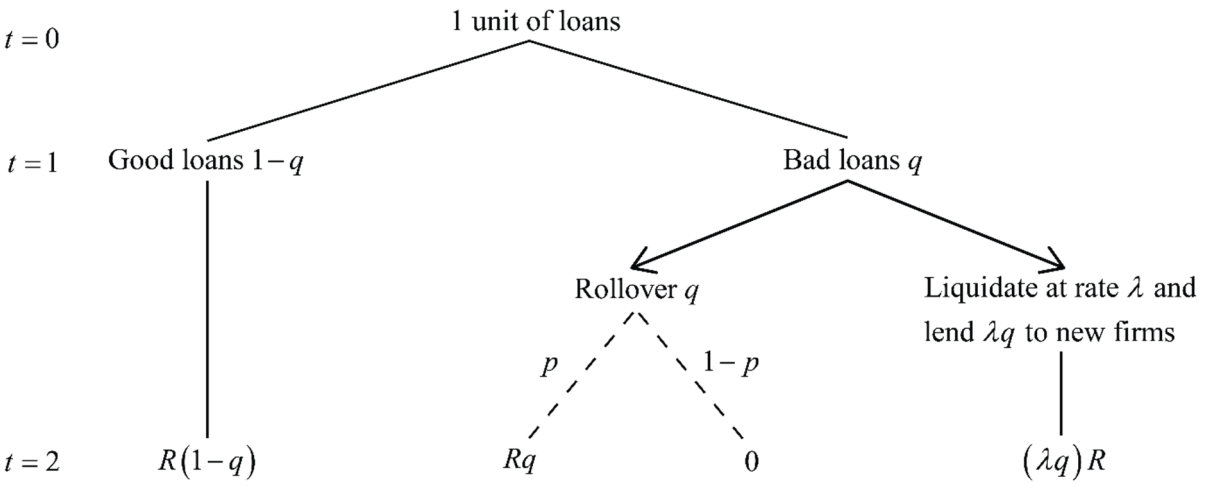

Figure 1: Loan characteristics

At $t = 0$ the bank makes 1 unit of loans. At $t = 1$ the bank and the regulator observe the quality of loans. A proportion of loans $1 - q$ is good; the remaining q are bad loans. At $t = 2$ good loans repay with certainty a cash flow R per unit of lending. If the bank rolls over the bad loans, they repay R with probability p and zero otherwise. If the bank liquidates bad loans it gets λ per unit of liquidated bad loans. The proceeds from liquidation are lent to new firms at a rate R .

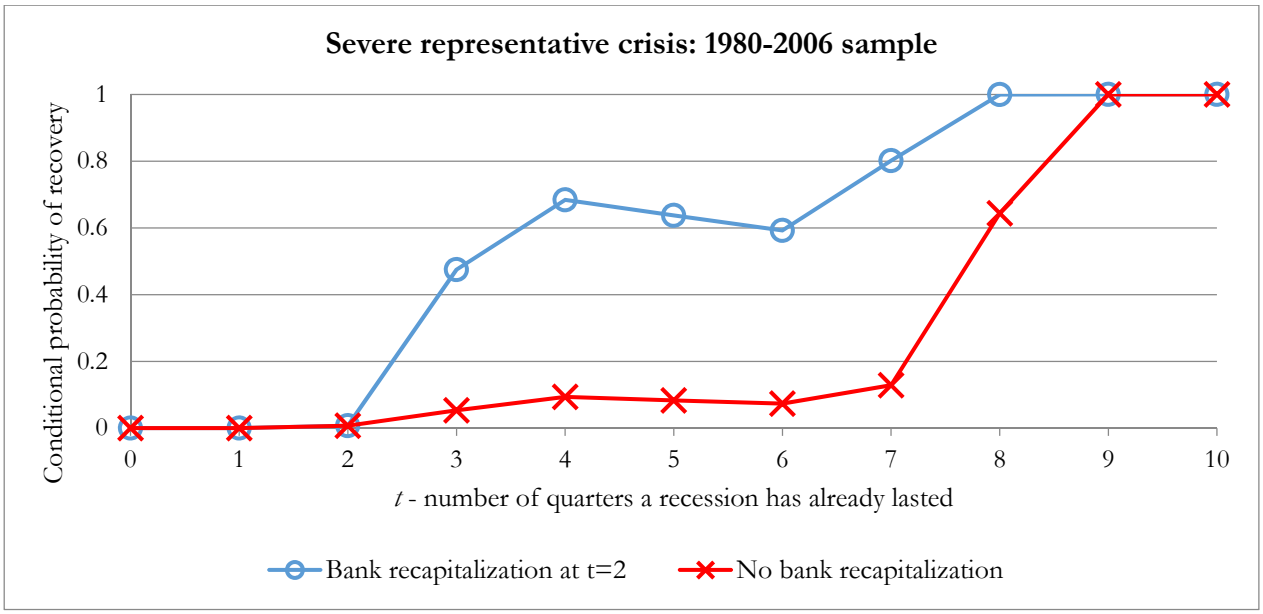

Figure 2: Predicted conditional probabilities of recovery for severe representative crisis of the 1980 to 2006 sample.

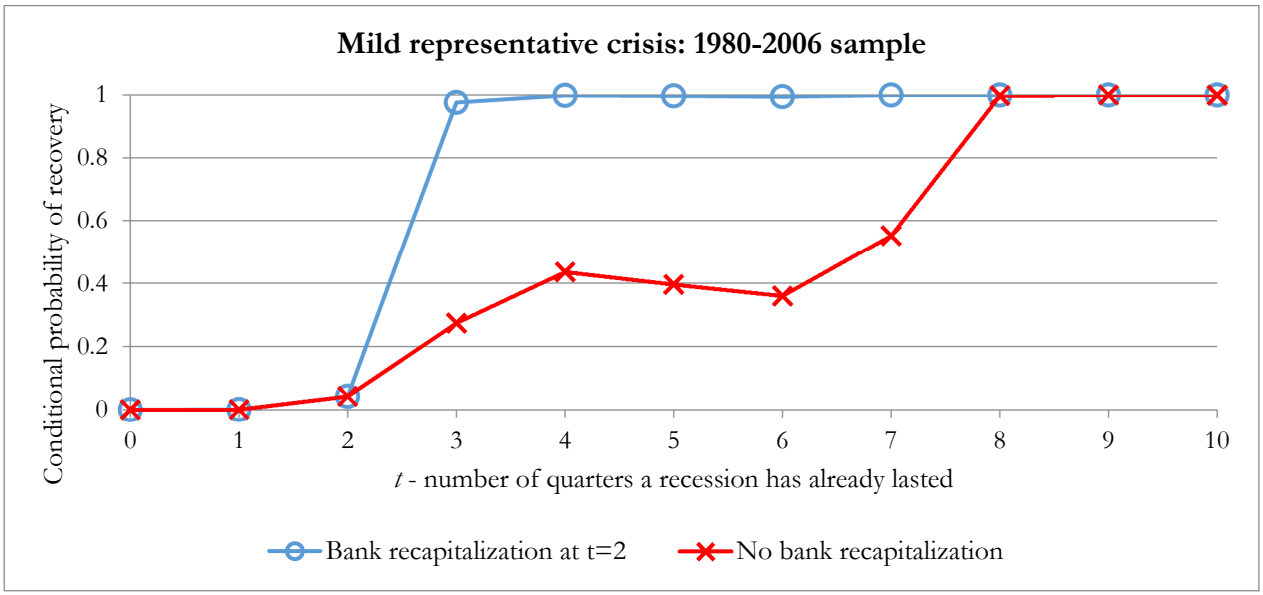

Figure 3: Predicted conditional probabilities of recovery for mild representative crisis of the 1980 to 2006 sample.

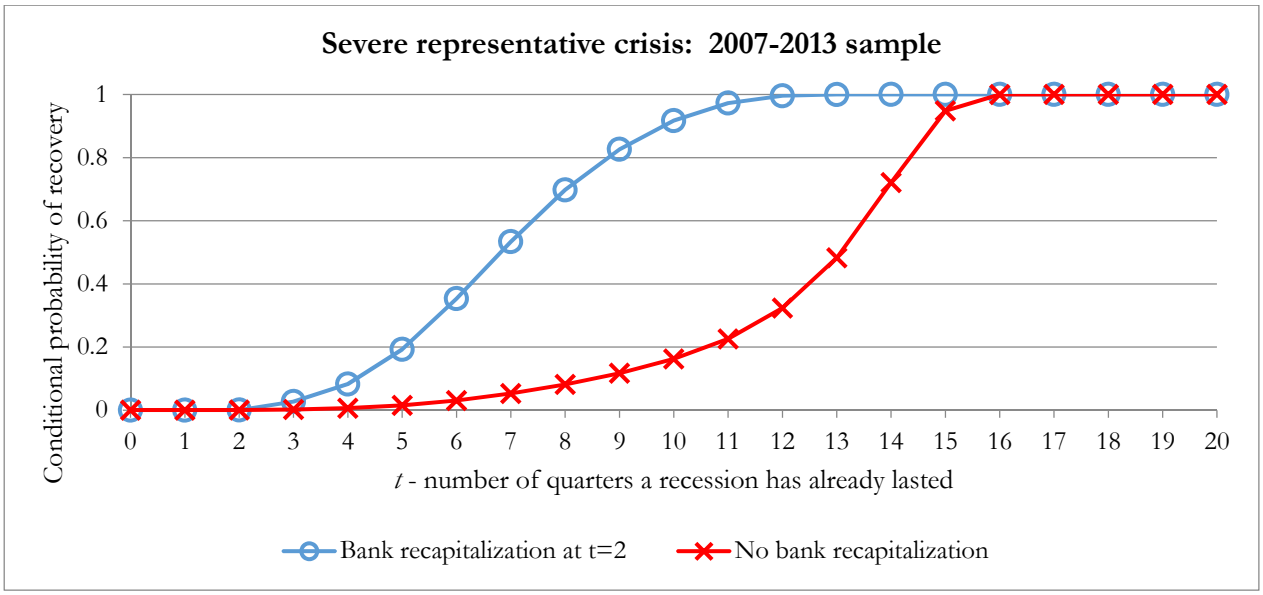

Figure 4: Predicted conditional probabilities of recovery for severe representative crisis, the 2007 to 2013 sample.

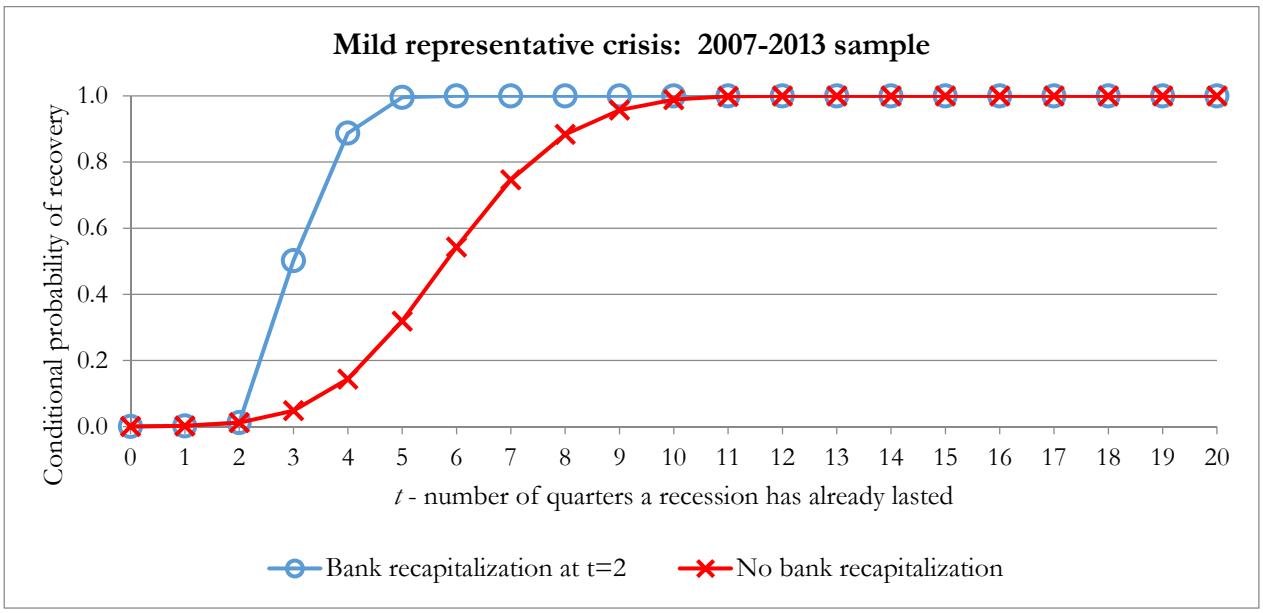

Figure 5: Predicted conditional probabilities of recovery for mild representative crisis of the 2007 to 2013 sample.

Table 1: Systemic banking crises in the period 1980 to 2006.

Country	Crisis start	Systemic crisis date	Recession start	Recovery	Recession duration	Duration of existing recession	Bank recap. date	Recap. end of recession	Recap. end of crisis
Argentina	1980 Mar	2000 Jan	1981 Q1	1983 Q1	8				
Argentina	1989 Dec	1989 Dec	1988 Q1	1990 Q3	10	7			
Argentina	1995 Jan	1995 Jan	1995 Q1	1995 Q4	3				
Argentina	2001 Nov	2001 Dec	2001 Q2	2002 Q2	4	2			
Bolivia	1994 Nov	1994 Nov							
Brazil	1990 Feb	1990 Feb	1990 Q1	1991 Q1	4				
Brazil	1994 Dec	1994 Dec	1995 Q2	1995 Q4	2				1.24
Bulgaria	1996 Jan	1996 Jun	1989 Q1	1998 Q1	36	28	1996 Q2	4.50	4.50
Chile	1981 Nov	1983 Mar	1981 Q4	1983 Q1	5				
Colombia	1982 Jul	1982 Jul							
Colombia	1998 Jun	1998 Jun	1998 Q3	1999 Q3	4			0.38	0.75
Cote d'Ivoire	1988	1988							
Croatia	1998 Mar	1998 Mar	1998 Q1	1999 Q3	6			2.40	8.37
Czech Republic	1996 Jun	1996 Jun	1996 Q4	1997 Q4	4				
Dominican Rep.	2003 Apr	2003 Apr	2003 Q1	2004 Q1	4	1			
Ecuador	1998 Aug	1998 Dec	1998 Q3	1999 Q4	5		1999 Q3	5.85	5.85
Estonia	1992 Nov	1992 Nov	1994 Q1	1995 Q2	5				
Finland	1991 Sep	1993 Feb	1990 Q2	1993 Q3	13	5	1992 Q4	2.89	3.46
Ghana	1982 Jan	1982 Jan	1982 Q1	1984 Q1	8				
Indonesia	1997 Nov	1997 Dec	1997 Q4	1999 Q3	7			20.10	58.14
Jamaica	1996 Dec	1997 Feb	1997 Q3	1998 Q2	3			1.51	1.51
Japan	1997 Nov	1997 Nov	1997 Q4	1998 Q3	3			0.15	0.75
Korea	1997 Aug	1997 Nov	1997 Q4	1998 Q3	3			0.87	3.33
Latvia	1995 Apr	1995 Apr							4.54
Lithuania	1995 Dec	1995 Dec							
Malaysia	1997 Jul	1998 Mar	1998 Q1	1999 Q1	4			0.58	1.18
Mexico	1994 Dec	1995 Jan	1995 Q1	1995 Q3	2			1.65	4.98
Nicaragua	2000 Aug	2001 Jan							
Norway	1990 Dec	1991 Oct	1991 Q3	1993 Q1	6		1991 Q4	3.08	3.08
Paraguay	1995 May	1995 Jul							
Philippines	1997 Jul	1998 Mar	1997 Q3	1998 Q4	5				
Russia	1998 Aug	1999 Jan							
Sri Lanka	1989	1989							
Sweden	1991 Sep	1992 Sep	1991 Q1	1993 Q1	8	2	1992 Q2	3.26	5.31
Thailand	1997 Jul	1997 Oct	1997 Q3	1998 Q4	5		1998 Q3	4.17	5.30
Turkey	2000 Nov	2000 Dec	2000 Q4	2002 Q1	5				2.64
Ukraine	1998 Aug	1998 Dec	1998 Q1	1999 Q1	4	2			
Uruguay	2002 Jan	2002 Apr	1999 Q1	2003 Q1	16	12		0.33	0.38
Venezuela	1994 Jan	1994 Jan	1994 Q1	1995 Q1	4		1994 Q2	24.61	24.61
Vietnam	1997 Nov	1998 Oct							

CRISIS START is the date when major distress in the banking sector was observed. SYSTEMIC CRISIS DATE is the date when the conditions for a banking crisis to be classified as systemic were met. RECESSION DURATION is in quarters. DURATION OF EXISTING RECESSION tells how long a recession has already been ongoing at the time of the banking crisis start. BANK RECAPITALIZATION DATE is the time when the main part of bank recapitalizations has been completed. RECAP. END OF RECESSION is the cumulative amount of bank recapitalizations at the end of the recession. RECAP. END OF CRISIS is the total amount of bank recapitalizations in a banking crisis (it includes also bank recapitalizations done after the recession has already ended). The recapitalization amounts are expressed in percent of total banking assets.

Table 2: Systemic banking crises in the period 2007 to 2013.

Country	Crisis start	Systemic crisis date	Recession start	Recovery	Recession duration	Duration of existing recession	Bank recap. date	Recap. end of recession	Recap. end of crisis
Austria	2008 Sep	2000 Jan	2008 Q3	2009 Q3	4		2009 Q2	1.10	1.46
Belgium	2008 Sep	2000 Jan	2008 Q3	2009 Q2	3		2008 Q4	2.81	4.27
Cyprus	2011 Jul	2013 Mar	2011 Q3		7		2013 Q1	17.86	17.86
Denmark	2008 Sep	2000 Jan	2008 Q3	2010 Q1	6		2009 Q2	1.22	1.34
France	2008 Sep		2008 Q2	2009 Q3	5	1		0.56	0.85
Germany	2008 Sep	2009 Oct	2008 Q2	2009 Q2	4	1	2009 Q1	0.81	1.35
Greece	2008 Sep	2009 May	2008 Q2	2009 Q2	4	1			1.27
Greece	2010 Apr	2012 May	2010 Q1		13	1	2012 Q2	6.86	6.86
Hungary	2008 Sep		2008 Q3	2009 Q4	5			0.15	0.15
Iceland	2008 Sep	2008 Oct	2008 Q3	2010 Q4	9		2009 Q4	11.13	11.13
Ireland	2008 Sep	2009 Jan	2008 Q1	2011 Q1	12	2	2010 Q4	9.52	14.30
Italy	2008 Sep		2008 Q2	2010 Q1	7	1		0.20	0.28
Kazakhstan	2008 Sep	2010 Sep							4.10
Latvia	2008 Sep	2000 Jan	2008 Q1	2009 Q4	7	2		2.01	6.67
Luxembourg	2008 Sep	2008 Sep	2008 Q2	2009 Q3	5	1	2008 Q4	0.92	0.95
Mongolia	2008 Sep	2009 Nov	2009 Q1	2010 Q1	4				2.49
Netherlands	2008 Sep	2008 Oct	2008 Q4	2009 Q3	3		2008 Q4	0.93	1.47
Nigeria	2009 Aug	2011 Oct							4.16
Portugal	2008 Sep		2008 Q1	2009 Q2	5	2			2.36
Russia	2008 Sep		2008 Q3	2009 Q3	4		2009 Q2	1.02	1.02
Slovenia	2008 Sep		2008 Q3	2009 Q3	4				1.95
Spain	2008 Sep	2011 Apr	2008 Q2	2010 Q1	7	1		0.06	0.36
Spain	2011 Sep	2012 Dec	2011 Q3	2013 Q3	8		2012 Q4	2.48	2.48
Sweden	2008 Sep		2008 Q1	2009 Q4	7	2			
Switzerland	2008 Sep		2008 Q4	2009 Q3	3			0.31	0.31
Ukraine	2008 Sep	2009 May	2008 Q2	2009 Q2	4	1		3.23	7.31
United Kingdom	2007 Sep	2008 Nov	2008 Q2	2009 Q4	6			0.53	0.97
United States	2007 Dec	2008 Oct	2008 Q1	2009 Q3	6		2008 Q4	1.35	1.36

For explanations of the different column headings see Table 1.

Table 3: Estimation results of the effects of intervention variables on the probability of recovery for the full sample of crises and the subsamples from the period 1980 to 2006 and 2007 to 2013.

Recession indicator	Full sample 1980-2013 (1)	Past crises 1980-2006 (2)	Recent crises 2007-2013 (3)	Recent crises 2007-2013 (4)
Bank recapitalizations	0.6637***	1.2636***	1.0449**	1.5126**
	(3.26)	(2.72)	(2.18)	(2.01)
Guarantees on bank liabilities	0.0133	-2.4110	0.3519	0.2769
	(0.02)	(-1.61)	(0.39)	(0.22)
Liquidity support	2.6676*	4.2064	-4.5830	-3.6067
	(1.76)	(1.47)	(-1.26)	(-0.80)
Growth of reserve money	-0.7330	-1.1811	-1.3611	
	(-1.56)	(-1.39)	(-1.21)	
Real interest rate reduction				0.2528*
				(1.89)
Fiscal deficit, cyclically adj.				0.2077
				(0.97)
Average of bank recapitalizations	-1.2208***	-2.0501***	-2.6339**	-3.2815**
	(-2.96)	(-2.63)	(-2.40)	(-1.97)
Average of guarantees on bank liab.	-0.2616	3.8550*	-2.2861	-2.3825
	(-0.29)	(1.94)	(-1.29)	(-1.19)
Average liquidity support	-3.1950	-2.1699	4.9049	2.3497
	(-1.46)	(-0.69)	(1.13)	(0.42)
Average reserve money growth	0.2569	0.1703	3.0066	
	(0.48)	(0.27)	(1.10)	
Average real interest rate reduction				-0.7642***
				(-2.90)
Average cyclically adj. fisc. def.				-0.2598
				(-0.97)
Duration	2.9566***	10.5926**	1.8332	1.5191
	(2.97)	(2.56)	(1.24)	(0.79)
Duration^2	-0.3936**	-2.1770**	-0.1576	-0.0479
	(-2.35)	(-2.46)	(-0.65)	(-0.14)
Duration^3	0.0147*	0.1419**	0.0034	-0.0044
	(1.76)	(2.39)	(0.28)	(-0.22)
Constant	-7.1750***	-17.5565***	-5.3922**	-5.1440
	(-3.96)	(-2.84)	(-1.97)	(-1.58)
Observations	317	147	170	170
Crises	51	26	25	25
Log likelihood	-89.7512	-37.4357	-39.5122	-35.8520

RECESSION INDICATOR is the dependent variable having value 1 if a country has just recovered from a recession and 0 if it is in a recession in a particular quarter. A positive regression coefficient means that a higher value of the explanatory variable increases the probability of recovery. BANK RECAPITALIZATIONS are the cumulative amount of recapitalizations since the start of the banking crises, weighted by total banking assets. GUARANTEES ON BANK LIABILITIES are an indicator variable for the presence of guarantees. LIQUIDITY SUPPORT is the ratio of central bank claims on other depository corporations divided by the total deposits at other depository corporations. GROWTH OF RESERVE MONEY and REAL INTEREST RATE REDUCTION are measures of monetary policy. CYCLICALLY ADJUSTED FISCAL DEFICIT is a measure of discretionary fiscal policy. All policy variables except for fiscal deficit are lagged one quarter. Averages of intervention variables are included to allow for correlation between intervention and the time invariant component of unobservable crisis severity. DURATION is the number of quarters a recession has already been ongoing until the period for which the probability of recovery is estimated. The specifications are estimated using complementary log-log random effects procedure. In parentheses are z-values of the tests for significance of coefficients. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 4: Estimation results of the effects of intervention variables on the probability of recovery for the full sample of crises and the subsamples from the period 1980 to 2006 and 2007 to 2013. Bank recapitalization indicator is used as a measure of bank recapitalizations.

	Full sample 1980-2013	Past crises 1980-2006	Recent crises 2007-2013	Recent crises 2007-2013
Recession indicator	**(1)**	**(2)**	**(3)**	**(4)**
Bank recapitalization indicator	2.5108***	2.4613**	3.1409**	2.6437**
	(3.33)	(2.13)	(2.31)	(2.01)
Guarantees on bank liabilities	0.1880	-2.4368	0.9789	0.8003
	(0.37)	(-1.46)	(1.19)	(0.80)
Liquidity support	1.5768	2.7520	0.4888	0.0719
	(1.09)	(1.02)	(0.16)	(0.02)
Growth of reserve money	-0.6270	-1.0170	-1.3002	
	(-1.25)	(-1.21)	(-1.19)	
Real interest rate reduction				0.1525
				(1.60)
Fiscal deficit, cyclically adj.				0.1431
				(0.86)
Average of bank recap. indicator.	-5.2089***	-4.9578**	-5.2014	-2.5858
	(-2.79)	(-2.00)	(-1.49)	(-0.74)
Average of guarantees on bank liab.	-0.7037	3.5793	-3.6670**	-2.3402
	(-0.85)	(1.64)	(-2.07)	(-1.35)
Average liquidity support	-2.6088	-1.3133	-3.8338	-7.5598
	(-1.25)	(-0.44)	(-0.79)	(-1.37)
Average reserve money growth	0.2661	0.0333	1.8759	
	(0.50)	(0.05)	(0.64)	
Average real interest rate reduction				-0.7108***
				(-2.88)
Average cyclically adj. fisc. def.				-0.2626
				(-1.30)
Duration	2.5049***	8.6194**	1.5378	2.2927
	(2.88)	(2.41)	(1.13)	(1.44)
Duration^2	-0.3177**	-1.7740**	-0.1267	-0.2011
	(-2.20)	(-2.25)	(-0.57)	(-0.82)
Duration^3	0.0118*	0.1184**	0.0031	0.0069
	(1.65)	(2.16)	(0.29)	(0.61)
Constant	-6.3985***	-14.5225***	-4.7048*	-6.8388**
	(-4.01)	(-2.79)	(-1.84)	(-2.12)
Observations	317	147	170	170
Crises	51	26	25	25
Log likelihood	-92.7037	-42.8870	-39.8077	-35.4818

RECESSION INDICATOR is the dependent variable having value 1 if a country has just recovered from a recession and 0 if it is in a recession in a particular quarter. A positive regression coefficient means that a higher value of the explanatory variable increases the probability of recovery. BANK RECAPITALIZATION INDICATOR denotes significant bank recapitalizations. GUARANTEES ON BANK LIABILITIES are an indicator variable for the presence of guarantees. LIQUIDITY SUPPORT is the ratio of central bank claims on other depository corporations divided by the total deposits at other depository corporations. GROWTH OF RESERVE MONEY and REAL INTEREST RATE REDUCTION are measures of monetary policy. CYCLICALLY ADJUSTED FISCAL DEFICIT is a measure of discretionary fiscal policy. All policy variables except for fiscal deficit are lagged one quarter. Averages of intervention variables are included to allow for correlation between intervention and the time invariant component of unobservable crisis severity. DURATION is the number of quarters a recession has already been ongoing until the period for which the probability of recovery is estimated. The specifications are estimated using complementary log-log random effects procedure. In parentheses are z-values of the tests for significance of coefficients. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 5: Expected and average observed recession durations for severe and mild crises.

	Full sample 1980-2013 (1)	Past crises 1980-2006 (2)	Recent crises 2007-2013 (3)	Recent crises 2007-2013 (4)
Severe crises				
Average actual duration	*6.18*	*5.60*	*6.42*	*6.42*
Expected duration without bank recapitalization	13.25	7.14	20.88	10.97
Expected duration with bank recapitalization	4.54	3.77	5.89	6.34
Difference in expected duration	8.72	3.37	14.99	4.63
Mild crises				
Average actual duration	*4.74*	*4.43*	*5.23*	*5.23*
Expected duration without bank recapitalization	5.25	4.50	5.80	5.59
Expected duration with bank recapitalization	3.03	2.98	3.10	3.53
Difference in expected duration	2.22	1.52	2.70	2.06

Severe crises are crises where significant bank recapitalizations are done at some point. Mild crises are crises where significant bank recapitalizations where never done. Average observed duration is the average recession duration of the group of crises to which a representative crisis refers. Expected recession durations are computed based on estimates from Table 4. The expected durations in each column correspond to estimates in the same column of Table 4 (i.e. the results reported in column (4) of Table 5 are based on the regression reported in column (4) of Table 4 etc.). Expected durations with bank recapitalization are computed assuming that bank recapitalization is done in the third recession quarter.

Table 6: Estimations with interaction terms between bank recapitalizations and other policies on the sample of 2007 to 2013 crises.

Recession indicator	Recent crises 2007-2013 (1)	Recent crises 2007-2013 (2)	Recent crises 2007-2013 (3)	Recent crises 2007-2013 (4)	Recent crises 2007-2013 (5)	Recent crises 2007-2013 (6)
Bank recapitalizations	1.5126**	3.2619***	1.8554**	1.4450**	3.0555***	4.3104***
	(2.01)	(2.68)	(2.10)	(2.03)	(2.67)	(2.58)
Guarantees on bank liabilities	0.2769	2.9221	0.0377	0.2640	0.3160	2.1610
	(0.22)	(1.48)	(0.03)	(0.20)	(0.24)	(0.94)
Guarantees * bank recap.		-1.7396*				-1.2486
		(-1.95)				(-1.22)
Liquidity support	-3.6067	-9.0823*	-2.0505	-4.3946	-2.9516	-3.5243
	(-0.80)	(-1.67)	(-0.43)	(-0.96)	(-0.73)	(-0.59)
Liquidity support * bank recap.			-1.0599			-0.6577
			(-0.90)			(-0.60)
Real interest rate reduction	0.2528*	0.4326**	0.2635**	0.4325**	0.4121**	0.6761***
	(1.89)	(2.44)	(2.07)	(2.36)	(2.54)	(2.68)
Real int. rate reduction * bank recap.				-0.0943		-0.0792
				(-1.48)		(-1.12)
Fiscal deficit, cyclically adj.	0.2077	0.1490	0.2368	0.2528	0.3454	0.2840
	(0.97)	(0.60)	(1.06)	(1.11)	(1.46)	(1.00)
Fiscal deficit, cycl. adj. * bank recap.					-0.1455**	-0.1066
					(-2.04)	(-1.07)
Average of bank recapitalizations	-3.2815**	-3.4216**	-4.0347**	-3.3727**	-4.1363***	-4.9512**
	(-1.97)	(-2.12)	(-2.06)	(-2.18)	(-2.63)	(-2.35)
Average of guarantees on bank liab.	-2.3825	-3.9103	-2.4671	-1.6997	-1.8643	-3.0673
	(-1.19)	(-1.58)	(-1.21)	(-0.79)	(-0.85)	(-1.08)
Average liquidity support	2.3497	4.2471	3.1108	2.9685	-3.0218	-0.5763
	(0.42)	(0.71)	(0.56)	(0.53)	(-0.46)	(-0.08)
Average real interest rate reduction	-0.7642***	-0.7404***	-0.8076***	-0.7302***	-0.8662***	-0.8682***
	(-2.90)	(-2.68)	(-2.93)	(-2.80)	(-3.09)	(-2.67)
Average cyclically adj. fisc. def.	-0.2598	-0.2403	-0.2686	-0.3118	-0.3919	-0.3261
	(-0.97)	(-0.76)	(-1.01)	(-1.10)	(-1.33)	(-0.96)
Duration	1.5191	0.9055	1.9354	1.2068	0.7594	0.0505
	(0.79)	(0.52)	(1.13)	(0.70)	(0.52)	(0.03)
Duration^2	-0.0479	-0.0258	-0.1686	-0.0140	0.0921	0.1435
	(-0.14)	(-0.08)	(-0.57)	(-0.05)	(0.35)	(0.54)
Duration^3	-0.0044	-0.0010	0.0058	-0.0045	-0.0119	-0.0102
	(-0.22)	(-0.06)	(0.35)	(-0.25)	(-0.84)	(-0.66)
Constant	-5.1440	-4.2767	-5.5431*	-4.7498	-4.1665	-3.4003
	(-1.58)	(-1.46)	(-1.77)	(-1.64)	(-1.64)	(-1.48)
Observations	170	170	170	170	170	170
Crises	25	25	25	25	25	25
Log likelihood	-35.8520	-33.6307	-35.5098	-34.6523	-33.6776	-31.9634

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Table 7: Robustness checks to investigate what drives the negative effect of squared bank recapitalizations on the sample of 2007 to 2013 crises.

Recession indicator	Recent crises 2007-2013 Cyprus included (1)	Recent crises 2007-2013 Cyprus excluded (2)	Recent crises 2007-2013 Excl. Cyprus and Greece II (3)	Recent crises 2007-2013 Excl. Cyprus, forecasts for Greece II (4)
Bank recapitalizations	2.7863***	2.3598**	2.3303**	2.2671**
	(2.87)	(2.15)	(2.12)	(2.12)
Bank recapitalizations^2	-0.1308***	-0.0194	-0.0175	-0.0700
	(-2.67)	(-0.17)	(-0.15)	(-0.69)
Guarantees on bank liabilities	0.7316	1.0895	1.1171	0.5362
	(0.60)	(0.86)	(0.85)	(0.45)
Liquidity support	-6.3882	-5.1881	-5.0584	-6.7820
	(-1.39)	(-1.03)	(-0.99)	(-1.49)
Real interest rate reduction	0.3910***	0.3954**	0.3936**	0.3566**
	(2.80)	(2.53)	(2.51)	(2.55)
Fiscal deficit, cyclically adj.	0.2030	0.1583	0.1527	0.2223
	(0.93)	(0.71)	(0.69)	(1.04)
Average of bank recapitalizations	-2.5039	-2.0080	-1.9551	-1.8155
	(-1.27)	(-0.93)	(-0.91)	(-0.89)
Average of bank recapitalizations^2	-0.0099	-0.2372	-0.2408	-0.1065
	(-0.07)	(-0.87)	(-0.89)	(-0.46)
Average of guarantees on bank liab.	-1.1421	-2.0740	-2.1035	-1.1290
	(-0.58)	(-0.96)	(-0.94)	(-0.57)
Average liquidity support	-6.3063	-3.7751	-3.7686	-4.8961
	(-0.97)	(-0.56)	(-0.56)	(-0.72)
Average real interest rate reduction	-0.8028***	-0.8345***	-0.8305***	-0.7864***
	(-3.11)	(-3.13)	(-3.10)	(-3.05)
Average cyclically adj. fisc. def.	-0.4198	-0.3070	-0.2993	-0.4262
	(-1.42)	(-1.00)	(-0.97)	(-1.46)
Duration	1.8593	0.7180	0.7081	2.9799**
	(1.08)	(0.39)	(0.38)	(2.16)
Duration^2	-0.1533	0.1005	0.1023	-0.3339*
	(-0.53)	(0.28)	(0.29)	(-1.73)
Duration^3	0.0042	-0.0128	-0.0129	0.0125*
	(0.28)	(-0.59)	(-0.59)	(1.68)
Constant	-5.3914*	-4.2224	-4.2288	-7.3350**
	(-1.70)	(-1.48)	(-1.48)	(-2.37)
Observations	178	170	156	173
Crises	26	25	24	25
Log likelihood	-34.0987	-33.2302	-33.2013	-34.4881

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Table 8: Robustness checks with lax and strict definitions of recession duration.

	Lax recession definition			Strict recession definition		
	Full sample 1980-2013	Past crises 1980-2007	Recent crises 2008-2013	Full sample 1980-2013	Past crises 1980-2007	Recent crises 2008-2013
Recession indicator	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Bank recapitalizations	0.4981***	0.5758**	1.5126**	1.4929***	10.4952***	1.5118*
	(3.01)	(2.19)	(2.01)	(3.41)	(2.83)	(1.79)
Guarantees on bank liabilities	0.2147	-0.7833	0.2769	0.0642	-9.5049**	1.1483
	(0.37)	(-0.55)	(0.22)	(0.10)	(-2.05)	(0.98)
Liquidity support	2.2820	4.1813**	-3.6067	1.3861	3.9983	-1.7372
	(1.54)	(2.09)	(-0.80)	(0.82)	(1.36)	(-0.36)
Growth of reserve money	-0.7008	-1.0296		-0.9572	-0.8084	
	(-1.44)	(-1.59)		(-1.33)	(-0.90)	
Real interest rate reduction			0.2528*			0.3013*
			(1.89)			(1.83)
Fiscal deficit, cyclically adj.			0.2077			0.1400
			(0.97)			(0.64)
Average of bank recapitalizations	-0.9101***	-0.9077**	-3.2815**	-2.4421***	-17.4654***	-1.5597
	(-2.79)	(-2.05)	(-1.97)	(-3.33)	(-2.83)	(-1.12)
Average of guarantees on bank liab.	-0.2221	2.0478	-2.3825	0.0612	13.2054**	-1.4321
	(-0.24)	(1.09)	(-1.19)	(0.06)	(2.15)	(-0.67)
Average liquidity support	-3.4466	-2.9527	2.3497	-1.5375	-3.6407	-1.0577
	(-1.50)	(-1.02)	(0.42)	(-0.66)	(-1.05)	(-0.16)
Average reserve money growth	0.3092	0.1960		0.1336	-0.0348	
	(0.58)	(0.29)		(0.26)	(-0.06)	
Average real interest rate reduction			-0.7642***			-0.5048
			(-2.90)			(-1.60)
Average cyclically adj. fisc. def.			-0.2598			-0.3113
			(-0.97)			(-1.08)
Duration	2.9867***	4.1362***	1.5191	10.6175***	14.7311***	12.6821**
	(3.37)	(2.91)	(0.79)	(3.65)	(2.73)	(2.02)
Duration^2	-0.4211***	-0.6572***	-0.0479	-2.1788***	-3.0337***	-2.3633*
	(-2.88)	(-2.65)	(-0.14)	(-3.50)	(-2.59)	(-1.86)
Duration^3	0.0174**	0.0311**	-0.0044	0.1405***	0.1954**	0.1453*
	(2.46)	(2.47)	(-0.22)	(3.35)	(2.48)	(1.78)
Constant	-7.1655***	-9.1529***	-5.1440	-16.9647***	-23.0266***	-22.2398**
	(-4.38)	(-3.66)	(-1.58)	(-3.93)	(-2.91)	(-2.18)
Observations	343	173	170	270	127	143
Crises	54	29	25	51	26	25
Log likelihood	-102.2606	-51.5714	-35.8520	-72.9453	-26.4058	-28.9011

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Table 9: Robustness checks with different estimation procedures.

	Logit			Linear probability model		
	Full sample 1980-2013	**Past crises 1980-2006**	**Recent crises 2007-2013**	**Full sample 1980-2013**	**Past crises 1980-2006**	**Recent crises 2007-2013**
Recession indicator	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Bank recapitalizations	0.9217***	1.9362**	1.7692**	0.0213**	0.0205*	0.0080
	(3.30)	(2.50)	(1.98)	(2.36)	(1.94)	(0.37)
Guarantees on bank liabilities	0.1109	-4.3222	0.1584	0.0550	0.0106	0.0333
	(0.15)	(-1.60)	(0.11)	(0.87)	(0.08)	(0.40)
Liquidity support	3.5145*	5.4953	-4.2407	0.0838	0.2241	-0.4243
	(1.70)	(1.42)	(-0.72)	(0.43)	(0.81)	(-1.44)
Growth of reserve money	-1.0666	-1.6619		-0.0666	-0.0538	
	(-1.61)	(-1.44)		(-1.26)	(-0.84)	
Real interest rate reduction			0.2987*			0.0177
			(1.84)			(1.31)
Fiscal deficit, cyclically adj.			0.2570			0.0213
			(0.96)			(1.53)
Average of bank recapitalizations	-1.6008***	-3.1527**	-3.8238*	-0.0294**	-0.0188	-0.0273
	(-3.25)	(-2.44)	(-1.94)	(-2.36)	(-1.25)	(-0.82)
Average of guarantees on bank liab.	-0.3524	6.4750*	-2.6210	-0.1028	0.0676	-0.1448
	(-0.31)	(1.91)	(-1.16)	(-1.21)	(0.43)	(-0.97)
Average liquidity support	-4.1150	-3.1733	2.6633	-0.3186	-0.1544	-0.0247
	(-1.47)	(-0.78)	(0.34)	(-1.45)	(-0.45)	(-0.07)
Average reserve money growth	0.3374	0.2478		0.0660	0.0518	
	(0.52)	(0.33)		(0.78)	(0.54)	
Average real interest rate reduction			-0.8285***			-0.0352
			(-2.59)			(-1.41)
Average cyclically adj. fisc. def.			-0.3184			-0.0292*
			(-0.99)			(-1.80)
Duration	3.1358***	11.0233**	1.8056	0.0191	0.0018	0.0285
	(2.60)	(2.25)	(0.80)	(0.47)	(0.02)	(0.52)
Duration^2	-0.3940*	-2.2231**	-0.0679	0.0143	0.0251	0.0128
	(-1.90)	(-2.07)	(-0.16)	(1.54)	(0.81)	(1.09)
Duration^3	0.0129	0.1439**	-0.0043	-0.0012**	-0.0020	-0.0009
	(1.20)	(1.96)	(-0.18)	(-2.17)	(-0.72)	(-1.33)
Constant	-7.5508***	-18.4472**	-5.4396	0.0707	-0.0172	0.1237
	(-3.52)	(-2.57)	(-1.44)	(1.28)	(-0.20)	(1.36)
Observations	317	147	170	317	147	170
Crises	51	26	25	51	26	25
Log likelihood	-88.6471	-37.0105	-36.6919			

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