The real effect of the TARP

Yuki Takahashi*

University of Luxembourg

June 2017

Abstract

This paper empirically investigates the effect of the TARP on firm investment and pins down the causal channel. Using loan origination data to match up loans and firms, and instrumental variable method to generate the counterfactual loan size in absence of the TARP, I find that the TARP reduced firm investment by nearly one sample standard deviation. The reduction in firm investment was due to a contraction in the recipient banks' loan size, especially loans to external finance dependent firms and firms with strong fundamentals. At the extensive margin, 89% of the loans the recipient banks provided during the post-TARP period were to firms that had previous lending transactions with at least one recipient bank. These findings suggest that the TARP distorted the recipient banks' lending incentive, which more than offset the positive effect from bank recapitalization. A general equilibrium analysis yields results that are consistent with these findings.

JEL Codes: G01, G21, G28

Keywords: financial crisis, bank, TARP, CPP, capital injection, bailout policy

*PhD Candidate, Luxembourg School of Finance, University of Luxembourg, 6 rue Richard Coudenhove-Kalergi, L-1359 Luxembourg, Luxembourg. Email: ytakahashi@alm.icu.ac.jp, Phone: +46-(0)72-564-7914. I thank Alexis Anagnostopoulos, Sandro Brusco, Dmytro Holod, Farzad Saidi, and Yiyi Zhou for their helpful comments.

The real effect of the TARP

"Those who said the program didn't work...were the people who had stigmatized [the TARP.]"

Henry Paulson, former Secretary of the Treasury[1]

1. Introduction

The Troubled Asset Relief Program (TARP) was the US Treasury's main policy response to the 2008 global financial crisis which aimed to recapitalize banks and to boost lending through injection of public capital into bank balance sheet. However, despite that nearly 10 years has passed since its implementation, there are still debates over whether the TARP was a "success" (Calomiris and Khan, 2015). As public capital injection has become a main policy tool to rescue troubled banks all over the world, this question is still important for policymakers as well as academics.

As the ultimate objective to boost bank lending is to stimulate economic activity, it is reasonable to assess the TARP based on that criteria, and the TARP potentially affected the economic activity mainly through two channels. One is recapitalization channel. As the recipient banks were more capitalized, they could have had larger lending capacity and benefited financially constrained borrowers with good investment opportunities. This channel is consistent with the theory (Diamond and Rajan, 2000), and the Treasury was likely to have had this channel in their mind.[2]

The other is incentive distortion channel. The TARP was designed to rescue troubled banks, and the recipient banks were designated to be risky regardless of their actual financial condition. So the recipient banks could have decreased lending to build up their capital to eliminate the misperception, which would have negatively affected financially constrained borrowers. This channel is often called stigma effect and has long been a main concern for bank bailout policies (Anbil, 2016). Since both channels could have worked in theory, the question is reduced to which channel empirically dominated the other.

In this paper, I empirically investigate the effect of the TARP on firm investment and pins down the causal channel. Using loan origination data to match up loans and firms, and instrumental variable method to generate the counterfactual of what the lending would have been in absence of the TARP, I show that the TARP reduced firm investment by nearly one sample standard deviation. The reduction in firm investment

[1] A remark made at the Financial Crisis Inquiry Commission on May 6, 2010: http://blogs.wsj.com/deals/2010/05/06/hank-paulson-defends-tarp-disses-bear-stearns/

[2] See their press release when they announced the TARP: https://www.treasury.gov/press-center/press-releases/Pages/hp1207.aspx

was due to that TARP recipient banks contracted loan size especially for external finance dependent firms and firms with strong fundamentals: they dropped loan size by 47% for firms with one sample standard deviation higher external finance dependence and by 60% for firms with one sample standard deviation higher total factor productivity. At the extensive margin, 89% of loans from TARP recipient banks during the post-TARP period went to firms with previous lending transactions with at least one recipient banks. Further, I conduct a general equilibrium analysis and confirm that these empirical findings are consistent with the implications of the general equilibrium model. Overall, these findings suggest that the TARP distorted the recipient banks' lending incentive, which more than offset the benefit from bank recapitalization.

The main contribution of this paper is to provide a direct causal evidence of the effect of the TARP on real economic activities. Although there are several studies that examine the effect of the TARP on real economic activities, none of them pins down the direct causal mechanism why the TARP had such effect, and this paper fills in this gap. For example, Norden et al. (2013) find that the TARP increased valuation of the borrower firms of the recipient banks, especially borrower firms that were risky, bank dependent, and had lending transactions with less capitalized small banks during the pre-crisis period. Berger and Roman (2016) find that states with high presence of TARP recipient banks increased employment and decreased bankruptcy, and that these states experienced increase in commercial real estate loans and off-balance sheet real-estate guarantees. While this evidence is suggestive, we ideally want to see more direct evidence.

A study of the TARP's incentive distortion effect is not new. For example, Duchin and Sosyura (2014) find that TARP recipient banks shifted their portfolio toward riskier assets within the same regulatory risk-weight category. However, this paper is the first to investigate the impact of the incentive distortion on real economic activities.

Note, however, that my findings do not contradict with the evidence that the TARP was an effective emergency policy measure to prevent deepening of the financial crisis (Veronesi and Zingales, 2010). Rather, my findings complement this evidence by suggesting that public capital injection should be considered as a tentative policy tool that should only be used during the peek of a financial crisis.

This paper proceeds as follows. Section 2 places the contribution of this paper in the literature. Section 3 presents the identification strategy. Section 4 describes the data. Section 5 presents the empirical results. Section 6 complements the empirical findings using a general equilibrium model. Section 7 concludes.

2. Literature review

In addition to the literature on the effect of the TARP on real economic activities, this paper is aligned with the literature on the effect of credit contraction on firm performance. Chodorow-Reich (2014) finds that US firms reduced employment of small and medium firms by about 1/2 to 1/3 by a sudden credit contraction due to the Lehman Brother's bankruptcy. Gan (2007) finds that sharp contraction of Japan's real estate price in the early 1990s decreased lending by 1/3 and investment by 1/5. Paravisini et al. (2015) find that the credit supply contraction in Peru caused by the global financial crisis of 2008 reduced firm export by 1.95% for 10% drop in credit supply on the intensive margin but not on the extensive margin. This paper contributes to this literature by showing that the TARP shifted the recipient banks' lending towards firms with less external finance dependent and less strong fundamentals, which resulted in a drop in firm investment for about one sample standard deviation.

This paper also contributes to the literature on the effect of government policies on bank incentive distortion. Peek and Rosengren (2005) find that the Japan's implicit government support for lending during the 1990s resulted in lending to unproductive firms. Heider et al. (2016) find that the negative interest rate policy in the Euro Area increased low-capitalized banks' risk taking. This paper provides evidence that the TARP distorted the recipient banks' lending incentive.

In addition, this paper contributes to the TARP literature in general by providing additional empirical evidence. Li (2013) finds that the recipient banks with weak capitalization increased bank lending. Wu (2015) finds that the TARP had a negligible effect on the recipient banks' lending increase. Montgomery and Takahashi (2014) find that the recipient banks decreased standalone bank lending. Black and Hazelwood (2013) find that the recipient banks originated riskier corporate loans, and Berger et al. (2016a) find that the recipient banks offered better loan contract terms especially for risky borrowers. Bayazitova and Shivdasani (2012) find that the stress test conducted in 2009 convinced investors that banks that received the stress tests were safe, but the TARP itself did not convince investors that the recipient banks were safe. Duchin and Sosyura (2012) find that TARP funds were more likely to be allocated to politically connected banks. Berger and Roman (2015) and Koetter and Noth (2015) find that the TARP distorted banking sector competition. Berger et al. (2016b) find that TARP recipient banks reduced contribution to the systemic risk, thanks to increased capital cushion. Liu et al. (2013) find that the TARP improved the recipient banks' financial health and long-run stock price. Semaan and Drake (2016) find that TARP recipient banks' idiosyncratic risk

stayed high for four years relative to non-recipient banks. Farruggio et al. (2013) find that while the TARP increased the recipient banks' stock price, market participants observed the TARP as a serious obstacle for recovery of market confidence and financial stability.

Moreover, this paper contributes to the literature on the effectiveness of public capital injection policy in general. Giannetti and Simonov (2013) find that size of public capital injection needs to be large enough to be effective using Japanese data. Kasahara et al. (2016) find that Japanese public capital injection shifted capital from low to high productivity firms. This paper provides the effectiveness of a public capital injection on firm investment through credit contraction channel.

Finally, this paper contributes to the literature on government bailout policies during a financial crisis. Gertler et al. (2012) find that quantitative easing drops interest rate spread in a DSGE model. Gertler and Karadi (2015) find that the Federal Reserve's forward guidance surprise affected market interest rates even when the short-term policy rate was zero. Berger et al. (2015) find that the Federal Reserve's discount window and Term Auction Facility increased both small and large banks' corporate lending. This paper provides effectiveness of public capital injection, one of the main government bailout policies.

3. Identification strategy

3.1. Effect on firm investment

The structural relationship of interest is the effect of the TARP on firm investment due to the recipient banks' change in loan allocation:

$$Investment_f = \alpha + \beta Loan\ change\ due\ to\ the\ TARP_b + \epsilon_{b,f} \tag{1}$$

Where subscripts b stands for bank and f for firm. If the recipient banks' change in loan allocation is orthogonal to the error term – if change in loan allocation by the recipient banks was unrelated to factors that affected firm investment – the OLS estimate of β yields the unbiased treatment effect of the TARP on firm investment due to change in loan allocation by the recipient banks.

However, we cannot observe the recipient banks' loan allocation in absence of the TARP, so cannot observe the recipient banks' change in loan allocation induced by the TARP – the actual loan size itself is not appropriate as it was a result of the TARP. In other words, we need the counterfactual of what would have been the recipient banks' loan allocation in absence of the TARP.

Thus, I use instrumental variable method as an identification strategy. Specifically, I estimate the following instrumental variable regression:

$$\begin{aligned} Investment_{b,f,l,t} = \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} \\ + \beta \widehat{\log(L_{b,f,l,t})} + \mathbf{X_{b,t-1}^{bank}}' \boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}' \boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t} \end{aligned} \tag{2}$$

Where subscripts b stands for bank, f for firm, l for loan, and t for year.

$\widehat{\log(L_{b,f,l,t})}$ is log of loan size change induced by the TARP, estimated in the first stage regression presented below.[3] Control variables are included so that the estimated loan size change is only due to the TARP.

The identification relies on the following assumptions. First, the excluded instrument (the difference-in-difference term in the first stage regression) should be uncorrelated with any factors that affect firm investment other than loan size change (the exclusion assumption). This assumption is plausible because it is plausible that conditional on the bank, firm, loan, and time controls, the Treasury's selection of TARP recipient banks and banks' decision to participate in the TARP were uncorrelated to the borrower firm investment.

Second, the the excluded instrument should be independent of the treated and non-treated outcomes – investment – and the endogenous variables – log of loan size (the independence assumption). This assumption is also plausible because difference-in-difference term is independent in a difference-in-difference model and the covariates of equation (2) are same as the first stage difference-in-difference equation.

Third, the excluded instrument should be correlated with loan size change (the instrument relevance). This condition is empirically validated with the 1st stage F-statistic for the excluded instrument.

3.2. First stage regression

The structural relationship of interest is the effect of the TARP on the recipient banks' loan size:

$$Loan_{b,f,l} = \alpha + \beta TARP_{b,f,l} + \epsilon_{b,f,l} \tag{3}$$

$Loan_{b,f,l}$ is size of loan l provided by bank b to firm f. If the TARP status is orthogonal to the error term – if being a recipient of the TARP was unrelated to factors that also affected the bank's loan size – the OLS estimate of β yields the unbiased treatment effect of becoming a TARP recipient on loan size.

[3] I take log to fit the model better, since the distribution of the loan size is likely to have positive skew.

However, the orthogonality assumption is unlikely to hold. First, loan size may have been different between TARP recipient and non-recipient banks even before the TARP. In fact, Bayazitova and Shivdasani (2012) find that there were significant non-randomness both in the Treasury's selection of TARP recipient banks and the selected banks' decision to participate in the TARP.

Second, firm-side conditions matter for the banks' decision to provide loans. Thus, if there were any differences in the borrower firms' conditions between TARP recipient and non-recipient banks, then the orthogonality condition is violated.

Further, TARP recipient banks and non-recipient banks may have specialized in loans for different purposes. For example, if TARP recipient banks were in a better position in offering loans for leveraged buyout but not for working capital needs, then we expect that TARP recipient banks dropped loans not because they received TARP funds but because there were less leveraged buyout and more working capital needs during the financial crisis. Also, if TARP recipient banks were more used to provide loans with other banks but coordination among banks became difficult during the financial crisis, then TARP recipient banks' loan size became smaller irrespective of the TARP.

Finally, macroeconomic condition is positively correlated with banks' loan allocation. Thus, the orthogonality condition is violated if the Treasury's decision to allocate TARP capital and/or banks' decision to participate in the TARP were correlated to the business cycle, which was true as the TARP was initiated because of the sharp business cycle contraction.

Taking into account these considerations, the empirically feasible relationship of interest takes the following difference-in-difference form

$$\begin{aligned}\log(L_{b,f,l,t}) = \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} \\ + \beta TARPRecipient_b * PostTARP_t + \mathbf{X_{b,t-1}^{bank}}'\boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}'\boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}\end{aligned} \tag{4}$$

Where $\log(L_{b,f,l,t})$ is log of loan size provided by bank b to firm f in loan l at year t.

$TARPRecipient_b$ is a dummy variable indicating TARP recipient bank. $PostTARP_t$ is a dummy variable indicating period after the TARP: 2008 and after. Interaction of these dummies is difference-in-differences term, the variable of interest indicating whether TARP recipient banks originated more syndicated loans as a lead bank.

α_b is bank fixed effects. Bank fixed effects control for time-invariant bank characteristics such as location, business line, managerial philosophy, etc., that affect banks' loan allocation decision. $\mathbf{X_{b,t-1}^{bank}}$ is a

vector of variables on bank characteristics. This vector includes log of bank size and proxies for factors of CAMELS rating system which bank regulators use to assess bank health and was likely to be used by the Treasury in determining TARP recipient banks: capital ratio (capital adequacy), ratio of non-performing assets to gross total assets (asset quality), bank age (management quality), return on gross total assets (earnings), ratio of cash and cash equivalents to gross total assets (liquidity), and ratio of loans to deposits (sensitivity of market risk)).[4][5]

$\alpha_{FirmCreditRating}$ and $\alpha_{FirmIndustry}$ are firm credit rating fixed effects and industry fixed effects, respectively. These fixed effects control for banks' decision to loan allocation due to difference in borrower credit rating and industry. $\mathbf{X^{firm}_{f,t-1}}$ is a vector of firm characteristics. This vector includes market-to-book ratio, cash flow, cash holdings, size, and long-term leverage ratio. It is known that these factors capture many unobserved firm heterogeneity (Almeida et al., 2012).

$\alpha_{LoanPurpose}$ is loan purpose fixed effects, which control for difference in the purpose loans are used. $X^{loan}_{l,t}$ is loan characteristics, a dummy variable indicating whether a loan is provided with single lead bank or multiple lead banks.

α_t is year-fixed effects, controlling for macroeconomic fluctuations.

$\epsilon_{b,f,t}$ is error term. As error term in multi-period data is usually serially correlated within same cross-sectional unit (bank), especially in a difference-in-difference setting where difference-in-differnce term exhibits strong serial correlation, standard errors are clustered at the each bank level following Bertrand et al. (2004).

The identification relies on that conditional on these bank, firm, loan, and time controls, TARP recipient banks and non-recipient banks exhibited the same time trend with respect to loan allocation decision in absence of the TARP (the parallel trend assumption), which I validate empirically.

4. Data

The main data source is DealScan. DealScan contains more than 70% of all US syndicated loans with detailed information of each loan such as members of the syndicate, their role in the syndicate, volume of each loan, recipient firms, purpose of the loan, etc. Use of syndicated loans adds an additional assumption

[4]CAMELS stands for the first letter of the following six factors: capital adequacy, asset quality, management quality, earnings, liquidity and sensitivity of market risk. I use proxy because actual factors used by the regulators are not available.

[5]Gross total assets are total assets plus the allowance for loan and lease losses, and the allocated transfer risk reserves. Since Call Report deducts these two items from total assets, I follow Berger and Bouwman (2013) and add back these items to obtain a better measure of bank asset size.

that banks behave in the similar way for standalone lending and syndicated lending, which is plausible. The sample spans from 2005 to 2010.[6] Data frequency is annual. Financial variables are expressed in million US dollars.

I aggregate loans (packages) at the lead lender level in each loan syndicate, because syndicate members other than the lead lender are simply investors which do not involve in borrower screening and monitoring. Definition of the lead lender follows Ivashina (2009).[7] When there are more than one lead lenders in one loan syndicate, I equally split the loan amount to each lead lender.

I drop loans provided to firms located outside the US, since my interest is the effect of the TARP on the US economy. I also drop loans provided to financial firms[8] since financial firms do not involve in real activities.

In addition, I drop loans provided by non-depository financial institutions (neither commercial bank nor bank holding company), located outside the US, or owned by non-US banks, to make TARP recipient and non-recipient banks comparable, because the potential TARP recipients were limited to depository institutions located and headquartered in the US.[9]

I match up DealScan data and Compustat data using the DealScan-Compustat link file of Chava and Roberts (2008). I also hand-match DealScan data and Call Report data, and banks' TARP receipt data based on bank name, location, and date of operation using the NIC database as Berger et al. (2016a).[10][11] Since TARP funds were allocated at the bank holding company level, I aggregate banks at their bank holding company level. For standalone banks and banks whose bank holding company was too small to file the Y-9C report, I use commercial bank data but add a dummy indicating commercial bank. This yields 5,295 loan-level observations with 46 banks, of which 31 banks are TARP recipients and 15 banks are non-recipients.

Table 1 Here

Table 1 summarizes the main variables for TARP recipient and non-recipient banks. Variable definitions are in appendix. Bank level variables other than commercial bank dummy and bank age, and firm level

[6] I define loan issuance date as the date in which the lead lender issues its facility.

[7] Specifically, I consider administrative agent as the lead lender, or sole lender if there is no other syndicate member. When there is no administrative agent in a loan syndicate, I consider agent, arranger, bookrunner, lead arranger, lead bank, or lead manager as the lead lender.

[8] Firms whose primary SIC code is 6000-6999.

[9] Banks are defined as lenders whose institution type is US bank.

[10] TARP receipt data is from the Treasury's Troubled Assets Relief Program Transactions Report as of October 27, 2010.

[11] https://www.ffiec.gov/nicpubweb/nicweb/SearchForm.aspx

variables other than log TFP and external finance dependence are winsorized at 1% level to prevent outliers to affect the results.

Overall, the table shows that there is significant heterogeneity between TARP recipient and non-recipient banks, and firms to which they provided loans, suggesting that results can be misleading without controlling for this heterogeneity. Specifically, panel A shows that TARP recipient banks provided larger loans than non-recipient banks on average, and were more likely to provide loans with more than one lead bank. Panel B shows that loan issuers of the TARP recipient banks were less likely to be a commercial bank. In addition, TARP recipient banks were larger, had higher non-performing assets, were older, had higher liquidity, and had higher loans to deposits ratio than non-recipient banks. Panel C shows that TARP recipient banks were more likely to provide loans to higher market-to-book ratio, lower cash flow, larger, more leveraged, and more productive firms than non-recipient banks.

5. Results

5.1. Effect on firm investment

Table 2 presents the main results.

Table 2 Here

Column 1 reports regression result from the difference-in-difference specification of equation (4) but replaced log loan size with firm investment. Coefficient estimate on the interaction term between TARP recipient dummy and post TARP dummy shows that after controlling for the selection bias, the TARP reduced firm investment by 0.2 or nearly one sample standard deviation of the treated group. Corroborating this, coefficient estimate on the interaction term between TARP recipient dummy and post TARP dummy in column 2, which again reports result from difference-in-difference specification of equation (4), shows that the TARP reduced the recipient banks' loan size by 0.45 log points or 36% ((exp(-0.45)-1)*100).

Looking at column 3, which reports result from instrumental variable regression of equation (2), coefficient estimate on instrumented log loan size shows that firm investment would have increased if TARP increased the recipient banks' loan size. However, we know from column 2 that the TARP reduced the recipient banks' loan size by 36%. Thus, the TARP reduced firm investment by 0.2 (0.44*log((100-36)/100)) or nearly one sample standard deviation of the treated group due to the reduction of the recipient banks' loan

size. This result satisfies instrument relevance condition, as F-statistic for the excluded instrument from the 1st stage regression is 11.76 which is above the rule of thumb of 10 suggested by Stock et al. (2002).

Finally, looking at column 4, which reports results of equation (2) but with OLS, coefficient estimate on log loan size shows that loan size has statistically and economically insignificant effect on firm investment. Thus, without generating the counterfactual using the instrumental variable method, we cannot observe the effect of the TARP on firm investment through reduction in the recipient banks' loan size.

5.1.1. Factors that drive the results

To investigate factors that drive the results in table 2, table 3 presents reduced form and 1st stage regressions without bank or firm control (columns 1 and 4), with bank control (columns 2 and 5), and with firm control (columns 3 and 6).

Table 3 Here

First, columns 1-3 show that the difference-in-difference term has no effect on firm investment without controlling for bank characteristics, but has the negative effect of similar magnitude as the full model in column 1 of table 2 when we control for bank characteristics.

Second, columns 4-6 show that the difference-in-difference term has more negative effect on loan size without controlling for either bank or firm characteristics, no effect on loan size when we control for bank characteristics, and the negative effect of similar magnitude as the full model in column 2 of table 2 when we control for firm characteristics.

Together, these results suggest that TARP recipient banks were in worse condition in allocating loans than non-recipient banks after the TARP, but lent to firms different from non-recipient banks. In addition, the contraction of loan size per se did not reduce the firm investment, but lending to kind of firms different from non-recipient banks and from pre-TARP period did.

5.1.2. Parallel trend check

To check the plausibility of the parallel trend assumption, I run the following regression where I replace the difference-in-difference term with sets of dummies that are 0 for non-TARP recipient banks and in years

other than the specified year:

$$\log(L_{b,f,l,t}) = \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \sum_{\tau \neq 2007} \beta^\tau D_t^\tau \\ * TARPRecipient_b + \mathbf{X_{b,t-1}^{bank}}' \boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}' \boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t} \tag{5}$$

Where D_t^τ equals 1 when $\tau = t$ and 0 otherwise, and τ ranges from 2005 to 2006, and 2008 to 2010.

Figure 1 plots OLS estimates of β^τs:

Figure 1 Here

Figure 1 shows the log loan size of the recipient banks relative to 2007, one year before the TARP. The figure shows that the loan size of TARP recipient banks was statistically indifferent from non-recipient banks during the pre-TARP period (2005-2007), suggesting that the parallel trend assumption is plausible conditional on the controls.

5.2. Effect on external finance dependent firms

To investigate to what kind of firms TARP recipient banks reduced loan size, I run the following triple-difference regression:

$$\log(L_{b,f,l,t}) = \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \beta_1 TARPRecipient_b \\ * PostTARP_t * ExtFinDepFirm_f + \beta_2 TARPRecipient_b * PostTARP_t \\ + \beta_3 TARPRecipient_b * ExtFinDepFirm_f + \beta_4 PostTARP_t \\ * ExtFinDepFirm_f + \mathbf{X_{b,t-1}^{bank}}' \boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}' \boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t} \tag{6}$$

Where $ExtFinDepFirm_f$ is Rajan and Zingales (1998)'s external finance dependence index (fraction of capital expenditure not financed by internal cash flow) of the industry to which firm f belongs to.[12]

The results are in table 4.

First, column 4 includes full control for bank, firm, and loan characteristics, and is least affected by the selection bias. Coefficient estimate on the triple interaction term among TARP recipient dummy, post dummy, and external finance dependence index is negative and statistically and economically significant: on average TARP recipient banks reduced loan size to firms whose external finance dependence index were

[12] Specifically, I first calculate each Compustat firm's fraction of capital expenditure not financed by internal cash flow for 1975-2000. I next take median of the fractions for each 2-digits SIC code to calculate external finance dependence index of each industry. I then drop maximum and minimum values to avoid outliers to drive the results.

one standard deviation higher than the average firms in the treated sample by 0.64 log points (-2.13*0.3) or 47% ((exp(-2.13*0.3)-1)*100). Thus, TARP recipient banks contracted their loan size especially for more external finance dependent firms.

Second, coefficient estimate on the triple interaction term in columns 1-3 is statistically insignificant, suggesting that TARP recipient banks were in a more suitable condition for lending to external finance dependent firms and external finance dependent firms were in a more suitable condition for borrowing from TARP recipient banks.

It is beyond the scope of this paper to investigate why the TARP recipient banks reduced loan size to more external finance dependent firms. However, one possible explanation is that the recipient banks wanted to avoid lending to firms who were vulnerable to change in bank lending condition to avoid potential losses in case the macroeconomic condition deteriorated further.

5.2.1. Dynamic effect

To investigate the year-by-year effect of the TARP on loan allocation to external finance dependence firms, I run the following regression where I replace the triple-difference term with sets of external finance dependence indices that are 0 for non-TARP recipient banks and in years other than the specified year:

$$\begin{aligned}\log(L_{b,f,l,t}) = \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \sum_{\tau \neq 2007} \beta_1^\tau D_t^\tau \\ * TARPRecipient_b * ExtFinDepFirm_f + \beta_2 TARPRecipient_b \\ * PostTARP_t + \beta_3 TARPRecipient_b * ExtFinDepFirm_f + \beta_4 PostTARP_t \\ * ExtFinDepFirm_f + \mathbf{X_{b,t-1}^{bank\,\prime}}\boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm\,\prime}}\boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}\end{aligned} \tag{7}$$

Where D_t^τ equals 1 when $\tau = t$ and 0 otherwise, and τ ranges from 2005 to 2006, and 2008 to 2010.

Figure 2 plots OLS estimates of β_1^τs:

Figure 2 Here

Figure 2 shows the log loan size of the recipient banks provided to external finance dependent firms relative to 2007, one year before the TARP. The figure shows that the loan size of TARP recipient banks to external finance dependent firms was economically indifferent from non-recipient banks during the pre-TARP period (2005-2007), suggesting that the parallel trend assumption is plausible conditional on the

controls. However, the the loan size of TARP recipient banks to external finance dependent firms economically and statistically significantly contracted relative to non-recipient banks during the post-TARP period (2008-2010).

5.3. Effect on firms with strong fundamentals

To further investigate to what kind of firms TARP recipient banks reduced loan size, I run the following triple-difference regression:

$$\begin{aligned}\log(L_{b,f,l,t}) = {} & \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \beta_1 TARPRecipient_b \\ & * PostTARP_t * \log FirmTFP_{f,t-1} + \beta_2 TARPRecipient_b * PostTARP_t \\ & + \beta_3 TARPRecipient_b * \log FirmTFP_{f,t-1} + \beta_4 PostTARP_t * \log FirmTFP_{f,t-1} \\ & + \beta_5 \log FirmTFP_{f,t-1} + \mathbf{X_{b,t-1}^{bank}}'\boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}'\boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}\end{aligned} \tag{8}$$

Where $\log FirmTFP_{f,t-1}$ is log of firm total factor productivity (TFP), a Solow residual of Cobb-Douglas production function from İmrohoroğlu and Tüzel (2014), who modifies Olley and Pakes (1996)'s TFP estimation method for Compustat data. TFP is lagged because banks observe last year's firm fundamentals in making loan allocation decision.

Table 5 reports the results.

Table 5 Here

First, column 4 includes full control for bank, firm, and loan characteristics, and least affected by the selection bias. Coefficient estimate on the triple interaction term among TARP recipient dummy, post dummy, and lagged log firm TFP is negative and statistically and economically significant: on average TARP recipient banks reduced loan size to firms whose log TFP was one standard deviation higher than the average firms in the treated sample by 0.91 log points (-2.28*0.4) or 60% ((exp(-2.28*0.4)-1)*100). Thus, TARP recipient banks contracted their loan size especially for firms with strong fundamentals.

Second, coefficient estimate on the triple interaction term in columns 1-2 – which do not control for bank or firm characteristics and bank characteristics, respectively – is statistically and economically significant with magnitude of about three times larger than in column 4, but is insignificant in column 3 which controls for firm characteristics. This suggests that firms avoided borrowing from TARP recipient banks, regardless of the recipient banks' condition.

Again, it is beyond the scope of this paper to investigate why TARP recipient banks contracted lending to firms with stronger fundamentals. However, one possible explanation is that the recipient banks simply wanted to avoid lending to firms that were more likely to use the loans for productive but potentially longer-term purposes so that the recipient banks could easily withdraw loans when they wanted to do so.

5.3.1. Dynamic effect

Again to investigate the year-by-year effect of the TARP on loan allocation to firms with strong fundamentals, I run the following regression where I replace the triple-difference term with sets of lagged log firm TFP that are 0 for non-TARP recipient banks and in years other than the specified year:

$$\begin{aligned}\log(L_{b,f,l,t}) = \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \sum_{\tau \neq 2007} \beta_1^\tau D_t^\tau \\ * TARPRecipient_b * \log FirmTFP_{f,t-1} + \beta_2 TARPRecipient_b * PostTARP_t \\ + \beta_3 TARPRecipient_b * \log FirmTFP_{f,t-1} + \beta_4 PostTARP_t * \log FirmTFP_{f,t-1} \\ + \beta_5 \log FirmTFP_{f,t-1} + \mathbf{X_{b,t-1}^{bank}}' \boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}' \boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}\end{aligned} \tag{9}$$

Where D_t^τ equals 1 when $\tau = t$ and 0 otherwise, and τ ranges from 2005 to 2006, and 2008 to 2010 as for the external finance dependence index regression.

Figure 3 plots OLS estimates of β_1^τs:

Figure 3 Here

Figure 3 shows the log loan size of the recipient banks provided to firms with strong fundamentals relative to 2007, one year before the TARP. The figure shows that the loan size of TARP recipient banks to firms with strong fundamentals was economically indifferent from non-recipient banks during the pre-TARP period (2005-2007), suggesting that the parallel trend assumption is plausible conditional on the controls. However, the the loan size of TARP recipient banks to firms with strong fundamentals economically and statistically significantly contracted relative to non-recipient banks during the post-TARP period (2008-2010).

5.4. Effect at the extensive margin

So far the results show that the TARP reduced firm investment through contraction of the recipient banks' loan size, especially loans to more financially dependent firms and firms with stronger fundamen-

tals. However, if firms switched from TARP recipient banks to non-recipient banks, the reduction in the investment might not have been as serious as I find.

Of the loans provided by TARP recipient banks during the post-TARP period (2008-2010), about 89% were to firms that borrowed from TARP recipient banks at least once during the pre-TARP period (2005-2007). Thus, although firms may have borrowed from non-TARP recipient banks as well, the findings are economically significant.

6. General equilibrium analysis

To confirm the empirical findings presented in the previous section are consistent within a general equilibrium framework, I run a computational simulation using a general equilibrium model and examine the effect of the TARP in absence of the incentive distortion channel. Specifically, I adds a TARP mechanism to the Gertler and Kiyotaki (2010)'s financial accelerator model and simulates a negative shock to asset price and a positive shock to the asset quantity banks hold at the same time. The negative shock represents financial crisis as Gertler and Kiyotaki and positive shock the TARP capital injection. For brevity I only present the positive shock and the related parameter calibrations below (see the appendix for the complete model as well as the steady state and parameter values).[13]

6.1. Analytical framework

I model the positive shock to the asset quantity banks hold as an AR(1) process.

$$S_{gt+1} = \rho_g S_{gt} + u_{t+1} \tag{10}$$

Where S_{gt} is the quantity of assets exogenously provided to banks at period t where a period corresponds to a quarter, ρ_g is persistence parameter, and u_{t+1} is the error term.

I calibrate the persistence parameter to be 0.82 to make the positive shock as close as the TARP: the Treasury started injecting capital from the 4th quarter of 2008 and 16.8% of the injected capital stayed in the banking sector by the end of the 4th quarter of 2010, or 8 quarters after the first injection.[14] Thus, by setting the persistence parameter to 0.82 we have 16.8% of the exogenously provided assets in the banking

[13] I refine and extend the earlier version of this analysis, which was published in the Economics Bulletin, Volume 35, Issue 2, under the title "Did the TARP Expand or Contract Bank Lending? A Numerical Simulation Using a Financial Accelerator Model."

[14] Troubled Assets Relief Program Transactions Report as of October 27, 2010.

sector by the end of the 9th period.

I set the quantity of the shock to u_{t+1} to 0.315 so that the following equality holds.

$$\frac{Q_g^{ss} S_{gt=0}}{N^{ss}} = \frac{\$204.9 \text{ billion}}{\$1{,}145.0 \text{ billion}} \tag{11}$$

Where $S_{gt=0}$ is the quantity of assets exogenously provided to banks at $t = 0$, Q_g^{ss} is steady state value of the government's purchase price of bank assets, and is 1.002. N^{ss} is steady state value of bank equity capital which is 1.762. \$204.9 billion is the total amount of the capital injected under the TARP,[15] and \$1,145.0 billion is total banking sector equity capital by the end of the 3rd quarter of 2008,[16] one quarter before the TARP injection.

Finally, I calibrate τ, the "pass-through" parameter of the TARP, or parameter that determines how much the TARP spending contributes to the output through increase in the government spending, to be 0.045. Since the GDP of the 4th quarter was \$14,564.1 billion,[17] the TARP spending was about 1.41% of the total GDP. Thus setting $\tau = 0.045$ gives us $\tau S_{gt=0} \approx 1.41\%$.

6.2. Simulation results

Figure 4 shows the simulation results. The solid line shows the impulse response functions of main policy variables without the TARP and the dashed line with the TARP.

Figure 4 Here

First, figure 4 shows that the model economy experiences about the same size of drop in bank lending with the TARP compared to no policy case.

Second, figure 4 also shows that the model economy experiences smaller decrease in bank equity capital and drop in loan-deposit spread with the TARP compared to no policy case. Thus, the TARP makes banking sector more solvent and reduces borrowing constraint firms face, consistent with the TARP's recapitalization effect.

Finally, figure 4 shows that although investment increases less with the TARP compared to no policy case, the economic magnitude is negligible: relative to the steady state value, the difference is about 2%

[15] Troubled Assets Relief Program Transactions Report as of October 27, 2010.
[16] http://www.federalreserve.gov/datadownload/Choose.aspx?rel=H.8.
[17] http://www.bea.gov/national/index.htm#gdp.

(0.003/0.157*100). Also, the lower increase is likely to be from a slight drop in labor during 10-20 quarters rather than bank lending drop, since with less labor marginal product of capital is lower.

Thus, the general equilibrium analysis is consistent with the empirical findings in the last section: it was the TARP's incentive distortion channel that dropped firm investment through bank lending contraction.

7. Conclusion

While the TARP recapitalized the recipient banks, it could also have distorted the recipient banks' lending incentive. This paper investigates the effect of the TARP on firm investment. Using loan origination data to match up loans and firms and instrumental variable method to generate the counterfactual of what the lending would have been in absence of the TARP, I find that the TARP dropped firm investment by 0.2 or nearly one sample standard deviation. This drop was due to the contraction of the recipient banks' loan size, especially for more external finance dependent firms and firms with strong fundamentals – 47% and 60% drop for firms with one sample standard deviation higher external finance dependence and with one sample standard deviation higher total factor productivity, respectively. Results from a general equilibrium analysis are consistent with these findings. Overall, the results suggest that the TARP distorted the recipient banks' lending incentive, which more than offset the benefit from recapitalization.

References

Almeida, H., Campello, M., Laranjeira, B., and Weisbenner, S. (2012). Corporate Debt Maturity and the Real Effects of the 2007 Credit Crisis. *Critical Finance Review*, 1(1):3–58.

Anbil, S. (2016). Managing Stigma During a Financial Crisis. Working Paper.

Bayazitova, D. and Shivdasani, A. (2012). Assessing TARP. *Review of Financial Studies*, 25(2):377–407.

Berger, A. N., Black, L. K., Bouwman, C. H., and Dlugosz, J. L. (2015). The Federal Reserve's Discount Window and TAF Programs: "Pushing on a String?". Working Paper.

Berger, A. N. and Bouwman, C. H. S. (2013). How does capital affect bank performance during financial crises? *Journal of Financial Economics*, 109(1):146–176.

Berger, A. N., Makaew, T., and Roman, R. A. (2016a). Do Borrowers Benefit from Bank Bailouts? The Effects of TARP on Loan Contract Terms. Working Paper, University of South Carolina.

Berger, A. N. and Roman, R. A. (2015). Did TARP Banks Get Competitive Advantages? *Journal of Financial and Quantitative Analysis*, 50(6):1199–1236.

Berger, A. N. and Roman, R. A. (2016). Did Saving Wall Street Really Save the Main Street? The Real Effects of TARP on Local Business Conditions. *Journal of Financial and Quantitative Analysis*.

Berger, A. N., Roman, R. A., and Sedunov, J. (2016b). Do Bank Bailouts Reduce or Increase Systemic Risk? The Effects of TARP on Financial System Stability. Research Working Papers 16-08, The Federal Reserve Bank of Kansas City.

Bertrand, M., Duflo, E., and Mullainathan, S. (2004). How Much Should We Trust Differences-In-Differences Estimates? *The Quarterly Journal of Economics*, 119(1):249–275.

Black, L. K. and Hazelwood, L. N. (2013). The effect of TARP on bank risk-taking. *Journal of Financial Stability*, 9(4):790–803.

Calomiris, C. W. and Khan, U. (2015). An Assessment of TARP Assistance to Financial Institutions. *Journal of Economic Perspectives*, 29(2):53–80.

Chava, S. and Roberts, M. R. (2008). How Does Financing Impact Investment? The Role of Debt Covenants. *The Journal of Finance*, 63(5):2085–2121.

Chodorow-Reich, G. (2014). The Employment Effects of Credit Market Disruptions: Firm-level Evidence from the 2008-09 Financial Crisis. *Quarterly Journal of Economics*, 129(1):1–59.

Diamond, D. W. and Rajan, R. G. (2000). A Theory of Bank Capital. *The Journal of Finance*, 55(6):2431–2465.

Duchin, R. and Sosyura, D. (2012). The politics of government investment. *Journal of Financial Economics*, 106(1):24–48.

Duchin, R. and Sosyura, D. (2014). Safer ratios, riskier portfolios: BanksŒş response to government aid. *Journal of Financial Economics*, 113(1):1–28.

Farruggio, C., Michalak, T. C., and Uhde, A. (2013). The light and dark side of TARP. *Journal of Banking & Finance*, 37(7):2586–2604.

Gan, J. (2007). The Real Effects of Asset Market Bubbles: Loan- and Firm-Level Evidence of a Lending Channel. *Review of Financial Studies*, 20(6):1941–1973.

Gertler, M. and Karadi, P. (2015). Monetary Policy Surprises, Credit Costs, and Economic Activity. *American Economic Journal: Macroeconomics*, 7(1):44–76.

Gertler, M. and Kiyotaki, N. (2010). Financial Intermediation and Credit Policy in Business Cycle Analysis. In Friedman, B. M. and Woodford, M., editors, *Handbook of Monetary Economics*, volume 3, pages 547–599. Elsevier.

Gertler, M., Kiyotaki, N., and Queralto, A. (2012). Financial crises, bank risk exposure and government financial policy. *Journal of Monetary Economics*, 59, Supplement:S17–S34.

Giannetti, M. and Simonov, A. (2013). On the Real Effects of Bank Bailouts: Micro Evidence from Japan. *American Economic Journal: Macroeconomics*, 5(1):135–167.

Heider, F., Saidi, F., and Schepens, G. (2016). Life Below Zero: Bank Lending Under Negative Policy Rates. Working Paper.

İmrohoroğlu, A. and Tüzel, Ş. (2014). Firm-Level Productivity, Risk, and Return. *Management Science*, 60(8):2073–2090.

Ivashina, V. (2009). Asymmetric information effects on loan spreads. *Journal of Financial Economics*, 92(2):300–319.

Kasahara, H., Sawada, Y., and Suzuki, M. (2016). The Effect of Bank Recapitalization Policy on Corporate Investment: Evidence from a Banking Crisis in Japan. CARF F-Series 399, The University of Tokyo.

Koetter, M. and Noth, F. (2015). Bank bailouts and competition: Did TARP distort competition among sound banks? ECB Working Paper 1804, European Central Bank, Frankfurt, Germany.

Li, L. (2013). TARP funds distribution and bank loan supply. *Journal of Banking & Finance*, 37(12):4777–4792.

Liu, W., Kolari, J. W., Tippens, K. T., and Fraser, D. R. (2013). Did capital infusions enhance bank recovery from the great recession? *Journal of Banking & Finance*, 37(12):5048–5061.

Montgomery, H. and Takahashi, Y. (2014). The economic consequences of the TARP: The effectiveness of bank recapitalization policies in the U.S. *Japan and the World Economy*, 32:49–64.

Norden, L., Roosenboom, P., and Wang, T. (2013). The Impact of Government Intervention in Banks on Corporate Borrowers' Stock Returns. *Journal of Financial and Quantitative Analysis*, 48(05):1635–1662.

Olley, G. S. and Pakes, A. (1996). The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica*, 64(6):1263–1297.

Paravisini, D., Rappoport, V., Schnabl, P., and Wolfenzon, D. (2015). Dissecting the Effect of Credit Supply on Trade: Evidence from Matched Credit-Export Data. *The Review of Economic Studies*, 82(1):333–359.

Peek, J. and Rosengren, E. S. (2005). Unnatural Selection: Perverse Incentives and the Misallocation of Credit in Japan. *The American Economic Review*, 95(4):pp. 1144–1166.

Rajan, R. G. and Zingales, L. (1998). Financial Dependence and Growth. *The American Economic Review*, 88(3):559–586.

Semaan, E. and Drake, P. P. (2016). TARP and the long-term perception of risk. *Journal of Banking & Finance*, 68:216–235.

Stock, J. H., Wright, J. H., and Yogo, M. (2002). A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments. *Journal of Business & Economic Statistics*, 20(4):518–529.

Veronesi, P. and Zingales, L. (2010). Paulson's Gift. *Journal of Financial Economics*, 97(3):339–368.

Wu, D. (2015). The Effects of Government Capital and Liquidity Support Programs on Bank Lending: Evidence from the Syndicated Corporate Credit Market. *Journal of Financial Stability*, 21:13–25.

Appendix

A. Variable definitions

A1. Loan-level variables

- Log loan size = log of sum of facility amounts in a loan (package). (Source: DealScan)
- Multiple lead lender = a dummy variable equals 1 for loans with multiple lead lenders, 0 otherwise. (Source: DealScan)

A2. Bank-level variables

- Commercial bank = a dummy variable equals 1 if a bank does not have its parent holding company or the parent holding company does not file Y-9C report. (Source: Call Report)
- Log gross total assets$_{-1}$ = log of gross total assets one year before. Gross total assets are defined as total assets plus the allowance for loan and lease losses and the allocated transfer risk reserves following Berger and Bouwman (2013). Winsorized at 1% level. (Source: Call Report)
- Capital ratio$_{-1}$ = ratio of total equity capital to gross total assets (one year lagged). Winsorized at 1% level. (Source: Call Report)
- Non-performing assets ratio$_{-1}$ = ratio of past due assets 90 days or more to gross total assets (one year lagged). For commercial banks, past due loans 90 days or more is used instead due to data availability. Winsorized at 1% level. (Source: Call Report)
- Age$_{-1}$ = year since establishment (one year lagged). (Source: Call Report)
- ROA$_{-1}$ = ratio of net earnings to gross total assets (one year lagged). Winsorized at 1% level. (Source: Call Report)
- Liquidity ratio$_{-1}$ = ratio of cash and cash equivalents to total deposits (one year lagged). Winsorized at 1% level. (Source: Call Report)
- Loan-to-deposit ratio$_{-1}$ = ratio of total loans to total deposits (one year lagged). Winsorized at 1% level. (Source: Call Report)

A3. Firm-level variables

- Investment = ratio of capital expenditure to the last year's property, plant, and equipment. Winsorized at 1% level. (Source: Compustat)
- Market-to-book ratio$_{-1}$ = ratio of total enterprise value (book value of debts plus market value of equity minus deferred taxes and investment credits) to total assets (one year lagged). Winsorized at 1% level. (Source: Compustat)
- Cash flow$_{-1}$ = ratio of net income plus depreciation and amortization to total assets (one year lagged). Winsorized at 1% level. (Source: Compustat)
- Log total assets$_{-1}$ = log of total assets (one year lagged). Winsorized at 1% level. (Source: Compustat)
- Cash holdings$_{-1}$ = ratio of cash and short-term investments to total assets (one year lagged). Winsorized at 1% level. (Source: Compustat)
- Long-term leverage ratio$_{-1}$ = ratio of total long-term debts (including due in one year) to total assets (one year lagged). Winsorized at 1% level. (Source: Compustat)
- Log TFP$_{-1}$ = log of Solow residual of a Cobb Douglas production function estimated as in İmrohoroğlu and Tüzel (2014) (one year lagged). (Source: İmrohoroğlu and Tüzel (2014)[18])

[18] http://www-bcf.usc.edu/ tuzel/TFPUpload/TFPData_updated_ImrohorogluTuzel.csv

- External finance dependence = Rajan and Zingales (1998)'s external finance dependence index to which the firm belongs to. Specifically, I first calculate each Compustat firm's fraction of capital expenditure not financed by internal cash flow for 1975-2000. I next take median of the fractions for each 2-digits SIC code to calculate external finance dependence index of each industry. I then drop maximum and minimum values to avoid outliers to drive the results. (Source: Compustat)

B. The DSGE model for computational simulation

This appendix describes the DSGE model used for computational simulation in the main text, which incorporates a TARP mechanism in the Gertler and Kiyotaki (2010)'s financial accelerator model. My additions to the Gertler and Kiyotaki's model are stochastic process of the asset quantity (equation (B17)), size of shock to the asset quantity, and calibration of two parameters τ and ρ_g.

The model considers an economy in which banks cannot divert assets borrowed from the interbank market: the economy with $\omega = 1$ in Gertler and Kiyotaki's model. There are households, good producing firms, (physical) capital producing firms, banks, and a government in the model.

B1. Physical setup

Equations (B1)-(B3) are the physical setup of the economy.

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{B1}$$

$$K_{t+1} = \psi_{t+1}[I_t + (1-\delta)K_t] \tag{B2}$$

$$Y_t = C_t + [1 + f(\frac{I_t}{I_{t-1}})]I_t + \bar{G} + \tau S_{gt} \tag{B3}$$

Equation (B1) characterizes production. Y_t is output at t, A_t is productivity of the economy at t which is set to 1, K_t is capital at t, and L_t is labor at t. α is share of capital in production.

Equation (B2) describes capital accumulation. I_t is investment at t and δ is depreciation rate of capital. ψ_{t+1} is stochastic shock to asset price at $t+1$.

Equation (B3) is the resource constraint. C_t is consumption at t, $\bar{G}$ is government expenditure in a normal time, which is set to 20% of output: $\frac{\bar{G}}{Y_t} = 0.2$ for any t. S_{gt} is assets injected by the Treasury under the TARP at t. τ is the "pass-through" parameter of the TARP that determines how much the TARP spending contributes to the output through increase in government spending.

$[1 + f(\frac{I_t}{I_{t-1}})]I_t$ is adjustment cost of investment, with $f(1) = f'(1) = 0$, $f''(\frac{I_t}{I_{t-1}}) > 0$ and $I\frac{f''}{f'} = 1.5$. So $f(.)$ is defined as $f(x) = x^{2.5} - 1$.[19]

[19]The author thanks Alexis Anagnostopoulos for this idea.

B2. Households' optimality condition

Equation (B4) is the households' optimality condition, or the first order condition with respect to deposits, D_{t+1}.

$$E_t \Lambda_{t,t+1} R_{t+1} = 1 \tag{B4}$$

Where

$$\Lambda_{t,t+1} = \beta \frac{u_{C_{t+1}}}{u_{C_t}}$$

$$u_{C_t} = (C_t - \gamma C_{t-1})^{-1} - \beta\gamma(C_{t+1} - \gamma C_t)^{-1}$$

$\Lambda_{t,t+1}$ is the households' stochastic discount factor from t to $t+1$. R_{t+1} is the gross return on deposits; bank deposits are riskless in this model. β is discount rate and u_{C_t} is the marginal utility of consumption at t. γ is parameter for habit formation of consumption. E_t is expectation operator conditional on information at t.

B3. Banks' optimality conditions

Equations (B5)-(B10) are the banks' optimality conditions.

$$\frac{\nu_{st}}{Q_t} = \nu_{bt} \tag{B5}$$

$$Q_t(S_t + S_{gt}) = \phi_t N_t + N_{gt} \tag{B6}$$

$$\nu_t = E_t \Lambda_{t,t+1} \Omega_{t+1} R_{t+1} \tag{B7}$$

$$\mu_t = E_t \Lambda_{t,t+1} \Omega_{t+1} (R_{kt+1} - R_{t+1}) \tag{B8}$$

$$N_t = (\sigma + \xi)[Z_t + (1-\delta)Q_t]\psi_t S_{t-1} - \sigma R_t D_{t-1} + (Q_{gt} - Q_t)[S_{gt} - (1-\delta)\psi_t S_{gt-1}] \tag{B9}$$

$$D_t = Q_t(S_t + S_{gt}) - (N_t + N_{gt}) \tag{B10}$$

Where

$$N_{gt} = Q_t S_{gt}$$

$$\mu_t = \frac{\nu_{st}}{Q_t} - \nu_t$$

$$\Omega_{t+1} = 1 - \sigma + \sigma(\nu_{t+1} + \phi_{t+1}\mu_{t+1})$$

$$\phi_t = \frac{\nu_t}{\theta - \mu_t}$$

$$R_{kt+1} = \psi_{t+1}\frac{Z_{t+1} + (1-\delta)Q_{t+1}}{Q_t}$$

Equation (B5) is the banks' first order condition with respect to assets they privately intermediate at t, S_t. ν_{st} is marginal value of assets at the end of t, ν_{bt} is marginal cost of interbank borrowing at the end of period t. Q_t is market price of asset at t.

Equation (B6) is banks' incentive constraint. ϕ_t is leverage ratio at t. N_t is bank equity capital at t and N_{gt} is equity capital injected by the Treasury, both measured at market value. Note that banks cannot divert assets injected via the TARP. ν_t is marginal cost of deposits at the end of period t. μ_t is excess value of one unit of assets relative to deposits at t, and θ is fraction of assets banks can divert.

Equations (B7) and (B8) are conditions that make the banks' value function linear. Ω_{t+1} is marginal value of bank equity capital at $t+1$ and R_{kt+1} is the gross return on assets at $t+1$. σ is banks' survival rate. Z_{t+1} is dividend payment at $t+1$ on assets intermediated at t or, since firms operate at zero profit condition, gross profits per unit of capital at $t+1$.

Equation (B9) is evolution of bank equity capital. ξ is transfer to newly entered banks. Q_{gt} is price the Treasury pays to purchase bank assets. Equation (B10) is balance sheet identity (bank liability entirely consists of deposits).

B4. Firms' optimality conditions

Equations (B11)-(B12) are firms' optimality conditions.

$$Z_t = \alpha A_t (\frac{L_t}{K_t})^{1-\alpha} \tag{B11}$$

$$Q_t = 1 + f(\frac{I_t}{I_{t-1}}) + \frac{I_t}{I_{t-1}} f'(\frac{I_t}{I_{t-1}}) - E_t \Lambda_{t,t+1} (\frac{I_{t+1}}{I_t})^2 f'(\frac{I_{t+1}}{I_t}) \tag{B12}$$

Equation (B11) is the good producing firms' first order condition with respect to capital at t, K_t, and equation (B12) is the capital good producing firms' first order condition with respect to investment at t, I_t.

B5. Market clearing conditions

Equations (B13)-(B14) are market clearing conditions.

$$S_t + S_{gt} = I_t + (1 - \delta) K_t \tag{B13}$$

$$(1 - \alpha) \frac{Y_t}{L_t} E_t u_{C_t} = \chi L_t^{\epsilon} \tag{B14}$$

Equation (B13) is the asset market clearing condition. Equation (B14) is labor market clearing condition. χ is utility weight of labor and ϵ is inverse Frisch elasticity of labor supply.

B6. Government policy

Equation (B15) determines the Treasury's pricing of bank assets.

$$0 = E_t \Lambda_{t,t+1} \Omega_{t+1} (R_{gkt+1} - R_{t+1}) \tag{B15}$$

Where

$$R_{gkt+1} = \psi_{t+1} \frac{Z_{t+1} + (1 - \delta) Q_{t+1}}{Q_{gt}}$$

R_{gkt+1} is the gross return on government-injected assets at $t + 1$. So the Treasury prices bank assets such that the excess return on government-injected assets over deposits equals 0.

B7. Stochastic processes

Equations (B16)-(B17) are the stochastic processes.

$$\psi_{t+1} = 1 + \psi^*_{t+1} \tag{B16}$$

$$S_{gt+1} = \rho_g S_{gt} + u_{t+1} \tag{B17}$$

Where

$$\psi^*_{t+1} = \rho \psi^*_t + e_{t+1}$$

Equation (B16) is a stochastic process of asset price which models the financial crisis. ρ is autoregressive factor and e_{t+1} is the error term.

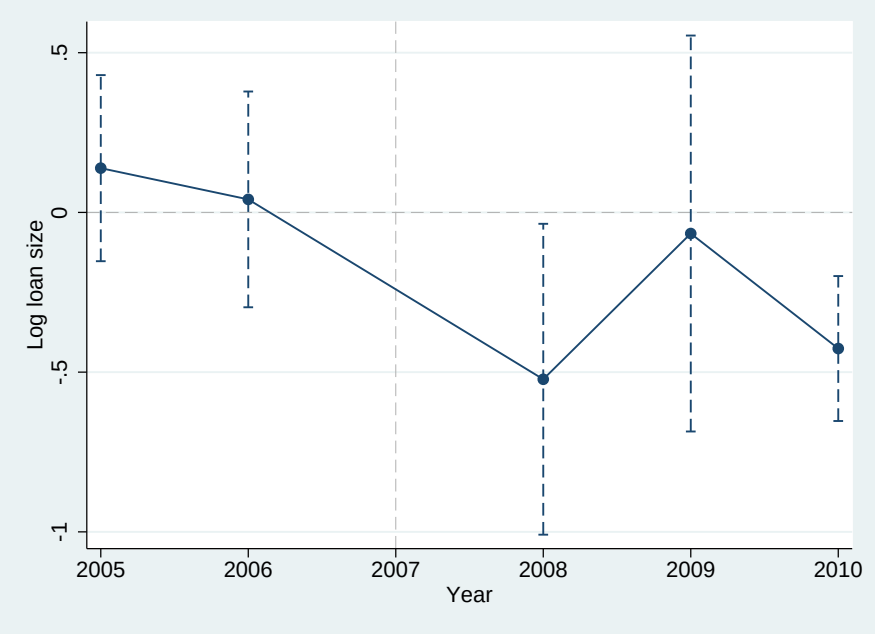
Equation (B17) is a stochastic process of asset quantity which models the TARP. S_{gt} is the quantity of assets exogenously provided to banks by the Treasury at period t, ρ_g is persistence parameter, and u_{t+1} is the error term.

The above seventeen numbered equations determine the economy: equations (B1)-(B15) determine three prices Q_t, Q_{gt}, R_{t+1}, three shadow prices ν_t, ν_{bt}, ν_{st}, and nine quantities Y_t, C_t, L_t, I_t, K_{t+1}, Z_t, D_t, N_t, S_t as functions of eight state variables K_t, C_{t-1}, I_{t-1}, ψ_t, R_t, D_{t-1}, S_{t-1}, S_{gt-1}. Equation (B16) determines ψ_{t+1} as a function of ψ^*_t and exogenous stochastic process e_{t+1}. Equation (B17) determines S_{gt} as a function of exogenous stochastic process u_{t+1}.

The steady state values for these endogenous variables are in table B1. Parameter values are in table B2.

Figures & Tables

Figure 1: Dynamic effect of the TARP on loan size (parallel trend check)

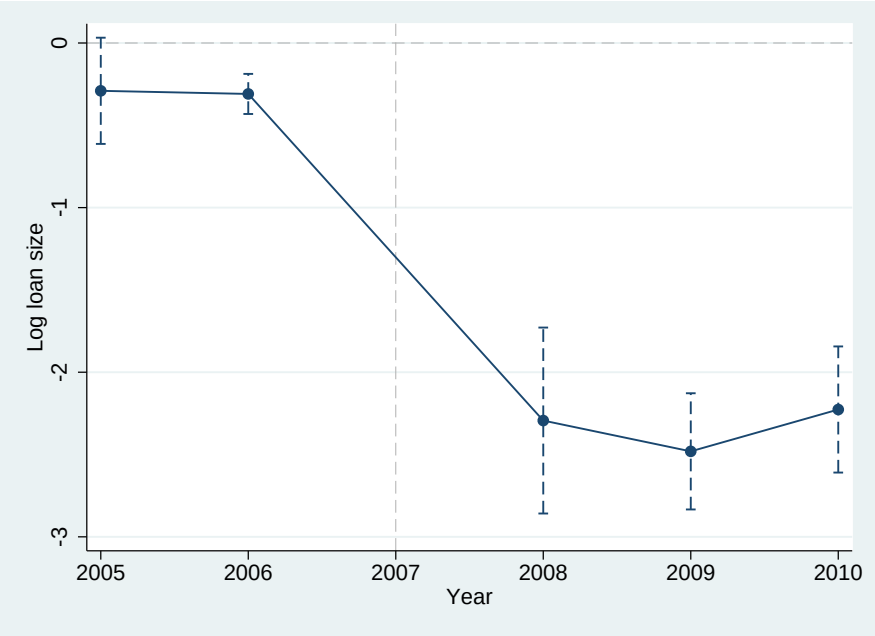


Note: This figure plots the year-by-year effect of the TARP on loan allocation relative to 2007, one year before the TARP. Specifically, this figure plots the OLS estimates of β^τs along with their 95% confidence intervals from the following regression:

$$\log(L_{b,f,l,t}) = \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \sum_{\tau \neq 2007} \beta^\tau D_t^\tau$$
$$* TARPRecipient_b + \mathbf{X_{b,t-1}^{bank}}' \boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}' \boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}$$

Where D_t^τ equals 1 when $\tau = t$ and 0 otherwise, and τ ranges from 2005 to 2006, and 2008 to 2010. Standard errors are clustered at the bank level.
The figure shows that the loan size of TARP recipient banks was statistically indifferent from non-recipient banks during the pre-TARP period (2005-2007), suggesting that the parallel trend assumption is plausible conditional on the controls.

Figure 2: Dynamic effect of the TARP on loan size to external finance dependent firms



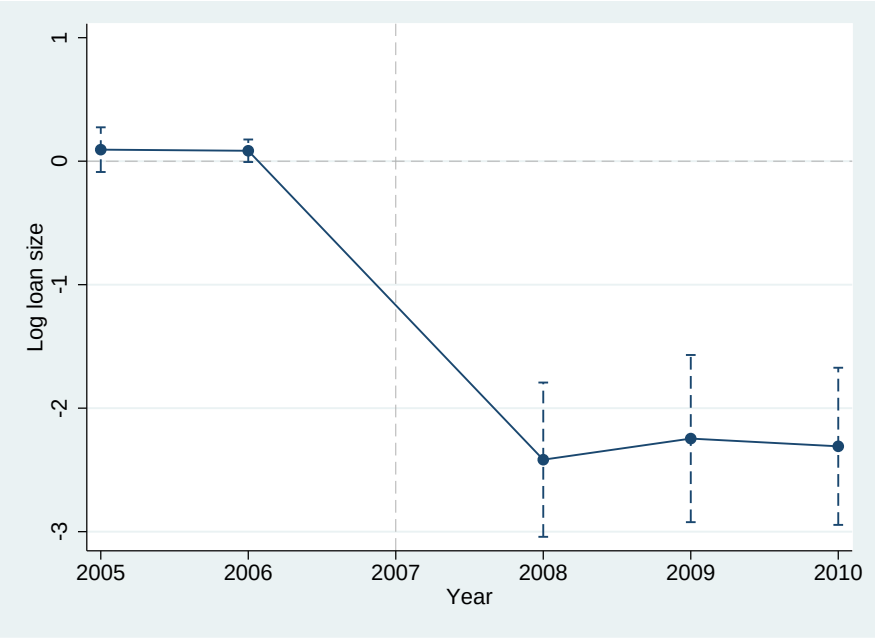
Note: This figure plots the year-by-year effect of the TARP on loan allocation to external finance dependence firms relative to 2007, one year before the TARP. Specifically, this figure plots the OLS estimates of β_1^τs along with their 95% confidence intervals from the following regression:

$$\begin{aligned}\log(L_{b,f,l,t}) = \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \sum_{\tau \neq 2007} \beta_1^\tau D_t^\tau \\ * TARPRecipient_b * ExtFinDepFirm_f + \beta_2 TARPRecipient_b \\ * PostTARP_t + \beta_3 TARPRecipient_b * ExtFinDepFirm_f + \beta_4 PostTARP_t \\ * ExtFinDepFirm_f + \mathbf{X_{b,t-1}^{bank}}' \boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}' \boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}\end{aligned}$$

Where D_t^τ equals 1 when $\tau = t$ and 0 otherwise, and τ ranges from 2005 to 2006, and 2008 to 2010. Standard errors are clustered at the bank level.

The figure shows that the loan size of TARP recipient banks to external finance dependent firms was economically indifferent from non-recipient banks during the pre-TARP period (2005-2007), suggesting that the parallel trend assumption is plausible conditional on the controls. However, the the loan size of TARP recipient banks to external finance dependent firms economically and statistically significantly contracted relative to non-recipient banks during the post-TARP period (2008-2010).

Figure 3: Dynamic effect of the TARP on loan size to firms with strong fundamentals



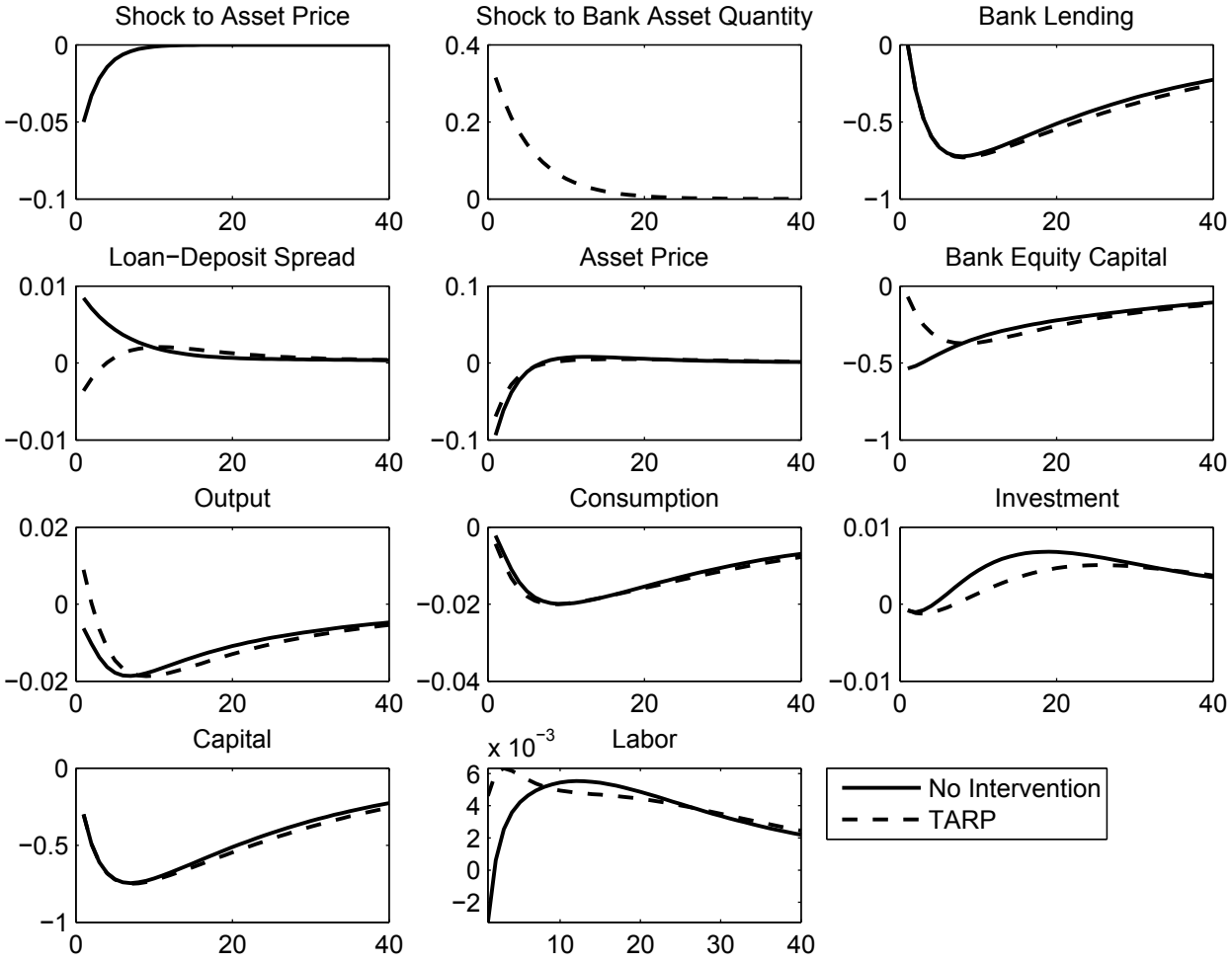
Note: This figure plots the year-by-year effect of the TARP on loan allocation to firms with strong fundamentals relative to 2007, one year before the TARP. Specifically, this figure plots the OLS estimates of β_1^τs along with their 95% confidence intervals from the following regression:

$$\begin{aligned}\log(L_{b,f,l,t}) = {} & \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \sum_{\tau \neq 2007} \beta_1^\tau D_t^\tau \\ & * TARPRecipient_b * \log FirmTFP_{f,t-1} + \beta_2 TARPRecipient_b * PostTARP_t \\ & + \beta_3 TARPRecipient_b * \log FirmTFP_{f,t-1} + \beta_4 PostTARP_t * \log FirmTFP_{f,t-1} \\ & + \beta_5 \log FirmTFP_{f,t-1} + \mathbf{X_{b,t-1}^{bank}}' \boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}' \boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}\end{aligned}$$

Where D_t^τ equals 1 when $\tau = t$ and 0 otherwise, and τ ranges from 2005 to 2006, and 2008 to 2010. Standard errors are clustered at the bank level.

The figure shows that the loan size of TARP recipient banks to firms with strong fundamentals was economically indifferent from non-recipient banks during the pre-TARP period (2005-2007), suggesting that the parallel trend assumption is plausible conditional on the controls. However, the the loan size of TARP recipient banks to firms with strong fundamentals economically and statistically significantly contracted relative to non-recipient banks during the post-TARP period (2008-2010).

Figure 4: Simulation results



Note: This figure plots impulse response functions for main policy variables obtained from the computational simulation in the main text. The solid line shows the impulse response functions simulated without the TARP and the dashed line with the TARP.

The figure confirms that the empirical findings are consistent within a general equilibrium framework. Specifically, in absence of the incentive distortion channel, bank lending is indifferent, interest rate spread faced by firms is lower, and bank equity capital is higher under the TARP scenario. In addition, although investment increases less under the TARP scenario, the economic magnitude is negligible. Also, the lower increase of investment is likely to be due to a slight drop in labor during 10-20 quarters rather than bank lending drop, since marginal product of capital is lower with less labor.

Table 1: Summary statistics

	TARP recipient banks					Non-TARP recipient banks				
	Obs.	Mean	Std. dev.	Min	Max	Obs.	Mean	Std. dev.	Min	Max
Panel A: Loan-level variables										
Log loan size	5,229	5.6	1.5	0.3	10.5	66	4.1	1.3	-0.9	6.2
Multiple lead lender	5,229	0.1	0.2	0	1	66	0.05	0.2	0	1
Panel B: Bank-level variables										
Commercial bank	5,229	0.001	0.03	0	1	66	0.1	0.3	0	1
Log gross total assets$_{-1}$	5,168	11.7	0.4	7.2	11.8	59	10.3	1.5	6.4	11.8
Capital ratio$_{-1}$	5,168	0.1	0.01	0.1	0.2	59	0.1	0.03	0.1	0.2
Non-performing assets ratio$_{-1}$	5,168	0.004	0.004	0	0.02	59	0.001	0.001	0	0.01
Age$_{-1}$	5,168	49.2	22.1	0	97	59	21.4	8.9	5	40
ROA$_{-1}$	5,168	0.01	0.01	-0.04	0.03	59	0.01	0.01	-0.01	0.02
Liquidity ratio$_{-1}$	5,168	0.2	0.1	0.02	0.6	59	0.06	0.04	0.02	0.2
Loan-to-deposit ratio$_{-1}$	5,168	1.7	0.3	0.6	2.4	59	1.1	0.3	0.5	2.1
Panel C: Firm-level variables										
Investment	4,360	0.3	0.3	0	4.5	57	0.4	0.4	0.02	2.0
Market-to-book ratio$_{-1}$	3,662	1.8	1.9	0.5	96.4	55	1.5	0.6	0.5	3.0
Cash flow$_{-1}$	4,271	0.5	3.5	-122.5	16.0	56	0.8	2.0	-8.9	8.7
Log total assets$_{-1}$	4,379	7.5	1.7	1.0	10.6	57	5.5	1.6	0.3	9.7
Cash holdings$_{-1}$	4,378	0.1	0.1	0	1.0	57	0.1	0.1	0.0001	0.4
Long-term leverage ratio$_{-1}$	4,299	0.3	0.2	0	2.4	56	0.2	0.2	0	0.9
Log TFP$_{-1}$	3,109	-0.2	0.4	-4.1	1.6	36	-0.3	0.3	-1.2	0.2
External finance dependence	4,437	0.2	0.3	-1.1	0.7	58	0.2	0.3	-0.4	0.6

Note: Source: DealScan (loan-level variables), Call Report (bank-level variables), Compustat (firm-level variables except Log TFP), the Treasury's Troubled Assets Relief Program Transactions Report (TARP status), and İmrohoroğlu and Tüzel (2014) (Log TFP). External finance dependence is calculated following Rajan and Zingales (1998).

DealScan data and Compustat data are matched up using the DealScan-Compustat link file of Chava and Roberts (2008). DealScan data and Call Report data, and banks' TARP receipt data are hand-matched based on bank name, location, and date of operation using the NIC database as Berger et al. (2016a).

Bank level variables other than commercial bank dummy and bank age, and firm level variables other than log TFP and external finance dependence are winsorized at 1% level to prevent outliers to affect the results.

Table 2: Effect on firm investment

	(1)	(2)	(3)	(4)
Specification	OLS (reduced form)	OLS (1st stage)	IV	OLS
Dependent variable	Investment	Log loan size	Investment	Investment
Log loan size			0.44**	0.01
			(0.18)	(0.01)
TARP recipient	-0.20***	-0.45***		
* Post	(0.06)	(0.13)		
Bank control	Yes	Yes	Yes	Yes
Firm control	Yes	Yes	Yes	Yes
Loan control	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Credit rating fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Loan purpose fixed effects	Yes	Yes	Yes	Yes
1st stage F-statistic	-	-	11.76	-
Observations	3,571	3,571	3,571	3,571
Number of banks	37	37	37	37
R-squared	0.31	0.74	-	0.31

Note: This table reports results from the following instrumental variable regression:

$$Investment_{b,f,l,t} = \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \beta \widehat{\log(L_{b,f,l,t})} + \mathbf{X_{b,t-1}^{bank}}' \boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}' \boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}$$

The table shows that (i) the TARP reduced firm investment by 0.2 or nearly one sample standard deviation (column 1), (ii) the TARP reduced the recipient banks' loan size by 36% (column 2), (iii) the reduction in firm investment was due to a contraction in the recipient banks' loan size (column 3), and (iv) we cannot find the results without generating the counterfactual using instrumental variable method (column 4).
Standard errors are clustered at the bank level. ***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Table 3: Factors that drive the results

	(1)	(2)	(3)	(4)	(5)	(6)
Specification	OLS (reduced form)			OLS (1st stage)		
Dependent variable	Investment			Log loan size		
TARP recipient	-0.01	-0.23**	-0.05	-0.76**	-0.49	-0.45**
* Post	(0.05)	(0.11)	(0.04)	(0.37)	(0.52)	(0.19)
TARP recipient	-0.08		0.01	1.71***		0.44*
	(0.07)		(0.05)	(0.24)		(0.24)
Bank control	No	Yes	No	No	Yes	No
Firm control	No	No	Yes	No	No	Yes
Loan control	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	No	Yes	No	No	Yes	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Credit rating fixed effects	No	No	Yes	No	No	Yes
Industry fixed effects	No	No	Yes	No	No	Yes
Loan purpose fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,417	4,361	3,619	5,295	5,227	3,626
Number of banks	37	37	37	39	39	37
R-squared	0.05	0.09	0.29	0.10	0.30	0.73

Note: This table reports results from the following difference-in-difference regression:

$$\log(L_{b,f,l,t}) = \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \beta TARPRecipient_b * PostTARP_t + \mathbf{X_{b,t-1}^{bank}}'\boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}'\boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}$$

The table shows that the contraction of loan size of TARP recipient banks per se did not reduce firm investment, but lending to kind of firms different from non-recipient banks and pre-TARP period reduced it.
Standard errors are clustered at the bank level. ***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Table 4: Effect on external finance dependent firms

	(1)	(2)	(3)	(4)
Specification	OLS			
Dependent variable	Log loan size			
TARP recipient * Post	-0.61	-0.71	-0.95	-2.13***
* External finance dependent firm	(1.38)	(1.51)	(1.20)	(0.24)
TARP recipient * Post	-0.60**	-0.27*	-0.24	0.25**
	(0.25)	(0.16)	(0.46)	(0.11)
TARP recipient	-0.17	0.08	-0.38	0.34**
* External finance dependent firm	(0.77)	(0.68)	(0.87)	(0.13)
Post	0.72	0.88	0.89	2.11***
* External finance dependent firm	(1.35)	(1.49)	(1.19)	(0.16)
TARP recipient	1.71***		0.53	
	(0.20)		(0.42)	
External finance dependent firm	-0.51	-0.52		
	(0.75)	(0.67)		
Bank control	No	Yes	No	Yes
Firm control	No	No	Yes	Yes
Loan control	Yes	Yes	Yes	Yes
Bank fixed effects	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Credit rating fixed effects	No	No	Yes	Yes
Industry fixed effects	No	No	Yes	Yes
Loan purpose fixed effects	Yes	Yes	Yes	Yes
Observations	4,495	4,439	3,617	3,569
Number of banks	37	37	37	37
R-squared	0.13	0.32	0.73	0.74

Note: This table reports results from the following triple-difference regression:

$$\begin{aligned}\log(L_{b,f,l,t}) = {} & \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \beta_1 TARPRecipient_b \\ & * PostTARP_t * ExtFinDepFirm_f + \beta_2 TARPRecipient_b * PostTARP_t \\ & + \beta_3 TARPRecipient_b * ExtFinDepFirm_f + \beta_4 PostTARP_t \\ & * ExtFinDepFirm_f + \mathbf{X_{b,t-1}^{bank}}'\boldsymbol{\gamma_1} + \mathbf{X_{f,t-1}^{firm}}'\boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}\end{aligned}$$

The table shows that TARP recipient banks contracted their loan size especially for more external finance dependent firms.
Standard errors are clustered at the bank level. ***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Table 5: Effect on firms with strong fundamentals

	(1)	(2)	(3)	(4)
Specification	OLS			
Dependent variable	Log loan size			
TARP recipient * Post	-6.11***	-6.78***	-1.61	-2.31***
* Log firm TFP$_{-1}$	(1.75)	(0.99)	(1.36)	(0.34)
TARP recipient * Post	-2.18***	-2.02***	-0.98	-1.07***
	(0.61)	(0.60)	(0.60)	(0.21)
TARP recipient	2.96***	2.70***	1.07	0.93**
* Log firm TFP$_{-1}$	(0.49)	(0.41)	(0.81)	(0.36)
Post * Log firm TFP$_{-1}$	5.97***	6.64***	1.61	2.31***
	(1.76)	(0.97)	(1.37)	(0.35)
TARP recipient	2.29***		0.75	
	(0.25)		(0.55)	
Log firm TFP$_{-1}$	-1.69***	-1.74***	-0.81	-0.71*
	(0.43)	(0.39)	(0.80)	(0.36)
Bank control	No	Yes	No	Yes
Firm control	No	No	Yes	Yes
Loan control	Yes	Yes	Yes	Yes
Bank fixed effects	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Credit rating fixed effects	No	No	Yes	Yes
Industry fixed effects	No	No	Yes	Yes
Loan purpose fixed effects	Yes	Yes	Yes	Yes
Observations	3,145	3,113	2,734	2,703
Number of banks	33	33	33	33
R-squared	0.23	0.37	0.75	0.76

Note: This table reports results from the following triple-difference regression:

$$\begin{aligned}\log(L_{b,f,l,t}) = {} & \alpha_b + \alpha_t + \alpha_{FirmCreditRating} + \alpha_{FirmIndustry} + \alpha_{LoanPurpose} + \beta_1 TARPRecipient_b \\ & * PostTARP_t * \log FirmTFP_{f,t-1} + \beta_2 TARPRecipient_b * PostTARP_t \\ & + \beta_3 TARPRecipient_b * \log FirmTFP_{f,t-1} + \beta_4 PostTARP_t * \log FirmTFP_{f,t-1} \\ & + \beta_5 \log FirmTFP_{f,t-1} + \mathbf{X^{bank}_{b,t-1}}'\boldsymbol{\gamma_1} + \mathbf{X^{firm}_{f,t-1}}'\boldsymbol{\gamma_2} + \gamma_3 X_l^{loan} + \epsilon_{b,f,l,t}\end{aligned}$$

The table shows that TARP recipient banks contracted their loan size especially for firms with strong fundamentals. Standard errors are clustered at the bank level. ***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Table B1: Steady state values

Variable	Value	Description
Y	0.707	Output
C	0.409	Consumption
L	0.241	Labor
I	0.157	Investment
K	6.269	Capital
Z	0.037	Gross profit per unit of capital
D	4.508	Deposits
N	1.762	Bank equity capital
S_p	6.269	Privately intermediated assets
Q	1.000	Market price of assets
Q_g	1.002	Price the Treasury pays to acquire bank assets
R	1.010	Gross return on deposits
ν	1.353	Marginal cost of deposits
ν_b	1.356	Marginal cost of interbank debt
ν_s	1.356	Marginal value of assets

Note: This table presents steady state values for variables used in the general equilibrium analysis in the main text.

Table B2: Parameter values

Parameter	Value	Description
β	0.990	Discount rate
γ	0.500	Parameter for habit persistence of consumption
χ	5.584	Relative utility weight of labor
ϵ	0.100	Inverse Frisch elasticity of labor supply
θ	0.383	Fraction of divertable assets
ξ	0.003	Transfer rate to a new bank
σ	0.972	Banks' survival rate
α	0.330	Share of capital in production
δ	0.025	Depreciation rate of capital
ρ	0.660	Persistence of asset price shock
ρ_g	0.820	Persistence of asset quantity shock
τ	0.045	"Pass-through" parameter of the TARP

Note: This table presents parameter values used for the general equilbrium analysis in the main text. ρ_g and τ are calibrated in the main text. Other parameters use Gertler and Kiyotaki (2010) 's calibration.