Effects of Government Bailouts on Mortgage Modification

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Abstract

This paper shows, for the first time, how liquidity infusions from government bailouts affect loan modification in the mortgage market. The design of the Pooling and Service Agreement leads mortgage servicers to prefer foreclosure to modification when the servicers are liquidity constrained. Therefore, a liquidity infusion is expected to boost modification rates. Using a residential mortgage dataset, including loan-level information, we find that liquidity infusions from the Troubled Asset Relief Program significantly increased the modification rate. Our findings help us better understand the economic consequences of government intervention and have important policy implications for the renegotiation of distressed mortgages.

Keywords: mortgage modification; financial crisis; TARP; government intervention; liquidity

JEL classification: E60, E65, G18, G21, H3

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1. Introduction

This paper is the first to examine how liquidity infusions from government bailouts affect debt renegotiation in the mortgage market – the origin of the global financial crisis that began at the end of 2007. The financial crisis induced a global economic recession and caught the attention of both industry actors and academics. Many financial institutions went bankrupt, and the financial status of many institutions seriously deteriorated during the crisis (Beltratti and Stulz, 2012; Gorton and Metrick, 2012).

The financial crisis was triggered by mortgage defaults and foreclosures. One important way to avoid foreclosure is mortgage modification: if a mortgage is in default due to the deterioration of the borrower's financial status, the borrower can seek to modify the mortgage contract. Mortgage modifications include interest rate reductions, term extensions, and principal write-downs, and they can reduce monthly payments so that the borrower can resume making scheduled payments and avoid foreclosure, which involves large losses. Foreclosures aggravated the financial crisis by pulling down housing prices in the neighborhood in which the affected house was located.

Mortgage modification has garnered the attention of academics and regulators due to its role in stemming the financial crisis. An extensive literature on various aspects of mortgage modification exists. However, there is little empirical research on the impacts of government policy on modification rates.[1] This paper examines how capital purchases through the Troubled Assets Relief Program (TARP) affect mortgage modification, which has important policy

[1] To the best of our knowledge, only one study, Agarwal et al. (2012), has addressed the Home Affordable Modification Program, which differs fundamentally from the bailout we examine. See the detailed discussion in Section 2.4.

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implications for addressing financial crisis.

Servicers (usually banks or their subsidiaries) play an important role in mortgage modification. If the borrower defaults and wants to modify the loan, he or she must petition the servicer who then decides whether to modify the mortgage on behalf of the holder. In the U.S. residential mortgage market, most mortgages are securitized, and servicers have a large impact on modification (Engel and McCoy, 2011; Thompson, 2011).[2]

The liquidity constraints of servicers during the financial crisis seriously reduced their willingness to modify mortgages. Mortgage modification requires servicers to have sufficient liquidity. After a mortgage borrower defaults, the servicer needs to advance monthly payments to the mortgage holder until a foreclosure or a mortgage modification is completed. In addition, the servicer needs to pay third parties for default services. The servicer obtains immediate compensation for these advances if the mortgage is foreclosed: reimbursement can be obtained from the proceeds of a sale of a home in foreclosure before the proceeds are transferred to the mortgage holder. By contrast, it takes much longer for the servicer to receive full compensation through a modification agreement because the servicer is only compensated for the advances from the monthly mortgage payments, which are much less than the lump-sum proceeds from the foreclosure sale. During the financial crisis, the deterioration of banks' asset liquidity and their liquidity hoarding behavior made them unwilling to pay these advances, so they preferred foreclosure to modification.[3]

[2] Agarwal et al. (2011a) use a dataset covering 64% of U.S. residential mortgages. In that dataset, approximately 61% of delinquent mortgages are securitized.

[3] Thompson (2011) describes the how the advance payment requirement encourages servicers to resolve delinquencies by foreclosure. We explicitly introduce that incentive in Section 2.2.

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Therefore, servicers' propensity to modify mortgages may increase significantly if liquidity was substantially improved during a financial crisis. In October 2008, the Emergency Economic Stabilization Act was enacted, and the government started the TARP. In total, there are thirteen programs under TARP, and the main one is the Capital Purchase Program (CPP), which invested $204.9 billion in the financial system. We focus on capital purchases and, hereafter, use the term "TARP" to refer to the CPP, following the literature (Berger and Roman, 2015). Capital purchases through TARP represented huge positive liquidity shocks that could dramatically enhance servicers' willingness to modify delinquent mortgages.[4]

The research question addressed in this paper is whether capital infusions from TARP increased banks' mortgage modification behaviors. To the best of our knowledge, this paper is the first to answer this question. We exploit a residential mortgage dataset from the Federal National Mortgage Association (Fannie Mae). This dataset contains detailed information on loan origination and performance. Specifically, it contains precise information on mortgage modification and servicers, which enables us to accurately assess the effects of TARP.

We use a difference-in-difference strategy to evaluate the impact of TARP. The treatment group includes mortgages whose servicers received funds through TARP, and the control group includes mortgages whose servicers were not exposed to TARP. We find that TARP increases the likelihood of modification by approximately 50%. This is a substantial impact and is not related to loan characteristics, origination year, default time, borrower credit quality, region fixed effects, servicer type, changes in default rates, or other government bailout programs. We also address

[4] As we discuss in Section 2.3, TARP aims to inject capital into the banking system rather than to increase mortgage modification. However, due to the important role of modification in the financial crisis, exploring the effects of TARP on modification would yield important policy implications.

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potential selection problems by considering the initial TARP recipients who were "forced" to take the bailout. We control for the liquidity conditions of the banks and find that liquidity injection explains at least 56% of the effect.

This paper makes three contributions to the literature. First, an increasing number of empirical studies address government assistance because of the recent bailouts. Many studies examine how TARP affects bank lending behaviors and risk taking (Black and Hazelwood, 2013; Li, 2013; Puddu and Wälchli, 2013; Duchin and Sosyura, 2014; A. N. Berger, Roman, and Sedunov, 2015; Bassett, Demiralp, and Lloyd, 2016). Another strand of the literature goes one step further and investigates how changes in bank lending behaviors affect firms (Lin, Liu, and Srinivasan, 2009; Norden, Roosenboom, and Wang, 2013; A. N. Berger, Makaew, and Roman, 2016). Additionally, a body of literature analyzes the effects of TARP on bank value and performance (Veronesi and Zingales, 2010; Bayazitova and Shivdasani, 2011; Kim and Stock, 2012; Berger and Roman, 2013; Liu et al., 2013; Ng et al., 2016).[5]

These studies analyze the consequences of government bailouts from different perspectives and substantially advance research in this field. However, few studies have considered how bailouts affect debt renegotiation. In the recent financial crisis, debt renegotiation, especially in the mortgage market, was considered an important way of preventing the crisis from deepening,

[5] There are also some studies on German government interventions. Gropp et al. (2013) show that banks reduced risk taking after government guarantees were removed, implying that public guarantees may be associated with substantial moral hazard. Berger et al. (2014) find that both regulatory interventions and capital infusion reduce bank risk taking. However, regulatory interventions also trigger decreases in liquidity creation, a core function of banks to support the macroeconomy.

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so both the government and financial institutions tried to promote modification.[6] Our study of the effects of government bailouts on mortgage modification fills this research gap and improves our understanding of the consequences of government bailouts.

The second related literature examines mortgage modification, which has been a popular topic since the onset of the financial crisis. An increasing number of studies have comprehensively analyzed mortgage modification (Clauretie and Jameson, 1994; Harding and Sirmans, 2002; Eggert, 2007; Stegman et al., 2007; Brinkmann, 2008; Cutts and Merrill, 2008; Cordell et al., 2009; Gelpern and Levitin, 2009; Magder, 2009; Posner and Zingales, 2009; Ghent, 2010; Piskorski et al., 2010; Agarwal et al., 2011a; Agarwal et al., 2011b; Morrison et al., 2011; Rose, 2011; Adelino, Gerardi, and Willen, 2013; Das and Meadows, 2013). For instance, many studies discuss factors that negatively affect mortgage modification. Piskorski et al. (2010) and Agarwal et al. (2011a) provide empirical evidence that securitization reduces the possibility of mortgage modification. Likewise, Agarwal et al. (2011b) argue that if the servicer of the first-lien mortgage is also the second-lien mortgage holder, mortgage modification would be deferred. Nonetheless, empirical research on government attempts to increase modification rates is scarce. One study by Agarwal et al. (2012), which quantifies the extent to which HAMP promoted mortgage modification, is closely related to ours. They find that this program increased the overall likelihood of mortgage modification but did not reach its target. HAMP provided subsidies to servicers, borrowers, and lenders for each successful modification. By contrast, TARP provided a lump-sum liquidity infusion, and it remains unclear how this type of government assistance affects mortgage modification. Our findings provide evidence of positive effects of liquidity infusions on mortgage modification and have meaningful policy implications for the promotion of mortgage

[6] For instance, the U.S. government launched the Home Affordable Modification Program (HAMP) in 2009.

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modification.

Finally, our paper adds to the literature on the importance of liquidity during the recent financial crisis. Deyoung et al. (2012) estimate the business loan supply function for small U.S. banks between 1990 and 2010 and find that illiquidity and information asymmetry lead to risk overhang that makes banks reduce the credit supply. Overhang effects are exacerbated by loan illiquidity and lower risk tolerance. Puri et al. (2011) disentangle the supply effects of the financial crisis on bank lending from the demand effects using a unique dataset on retail bank lending in Germany. They find that the subprime mortgage crisis induced a contraction in the supply of retail lending and that this contraction was particularly severe for liquidity-constrained banks. These studies highlight the role of bank liquidity in the credit supply, while in our research, we demonstrate that the improvement of liquidity boosts the mortgage modification rate. Therefore, this study enhances our understanding of the importance of liquidity constraints during the financial crisis.

The rest of this article is organized as follows. Section 2 introduces the background and intuition in detail. Then, Section 3 describes our data and the methodology. Sections 4, 5 and 6 present the empirical results. Finally, Section 8 discusses the findings and the conclusions from the study.

2. Background

2.1. Mortgage Modification

The subprime crisis that began in 2007 led to a large number of delinquent mortgages, and the foreclosures subsequently reached unprecedented levels. There were at least 700,000 foreclosures

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beginning in 2007, and the number of foreclosures soared to 2.2 million in 2008, with even more in the following years (Agarwal et al., 2012).

Foreclosures are costly to both individuals and the economy as a whole. Mortgage borrowers and lenders suffer from substantial deadweight losses. Additionally, foreclosures have negative externalities in the economy. When a house enters or is about to enter the foreclosure process, the homeowner does not carefully maintain it because he or she will lose ownership of the house soon. Thus, the quality of the house deteriorates, and the house value substantially decreases. Meanwhile, forced sales of homes in foreclosure push down housing prices in nearby areas by creating an imbalance of demand and supply in the illiquid neighborhood housing market, increasing the supply and reducing the price. This decline in housing prices further encourages borrowers to default (Anenberg and Kung, 2013; Biswas, 2012; Campbell et al., 2011; Daneshvary and Clauretie, 2012; Fisher et al., 2014; Gerardi et al., 2012; Harding et al., 2009; Immergluck and Smith, 2006; Schuetz et al., 2008; Whitaker and Fitzpatrick IV, 2013; White, 2009). As defaults become more common, the social stigma associated with default is reduced, which in turn encourages more defaults and foreclosures (Guiso et al., 2009).

One way to reduce foreclosures is to encourage mortgage modification. When a borrower defaults on a mortgage, the borrower can apply for a mortgage modification, and the servicer can modify the terms of the mortgage: the interest rate may be reduced, the term may be extended such that the outstanding balance is amortized over a longer period and monthly payments are attenuated, or a part of the principal may be written off. Modifications of these terms, individually or in combination, can change the borrower's monthly payments. Mortgage modification may yield some losses for mortgage holders but it can reinstate the loan status to current, unlike other methods, and it avoids the greater loss of foreclosure. Therefore, modification may help the

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housing market recover. Agarwal et al. (2013) show that regions with more exposure to HAMP have higher housing price growth rates relative to regions with limited program exposure.

2.2. Servicer and Liquidity

A mortgage servicer is an institution that performs services associated with mortgages and mortgage-backed securities (MBS). The servicer may or may not be a subsidiary of the mortgage originator, which is a bank in most cases. When the borrower wants to modify the mortgage, the borrower needs to submit an application to the servicer. The servicer decides whether to pursue foreclosure or to modify the delinquent mortgage on behalf of investors (Agarwal et al., 2012). Thus, the outcome of the modification application is highly dependent on the servicer's attitude toward modification.

Servicers have incentives to modify delinquent mortgages. The majority of a servicer's income comes from service fees. If the delinquent mortgage is modified and its status returns to current, the servicer will receive these fees periodically in the future, which does not happen in the case of foreclosure because mortgage services are terminated with liquidation.

During the financial crisis, the banks (the servicers) became liquidity constrained. The crisis, for instance, reduced the liquidity of banks' assets. Moreover, banks wanted to hold more liquid assets and were reluctant to use them during the crisis. For example, banks might hoard their liquidity as precautionary reserves for future liquidity demand (Acharya and Skeie, 2011). Therefore, liquidity demands increased, and we can consider banks more liquidity constrained than they were before crisis.

Liquidity constraints seriously inhibit the servicer's propensity to modify a mortgage because mortgage modification requires the servicer to have sufficient liquidity. Thompson (2011) provides thorough discussion of this mechanism. After the mortgage borrower defaults, the

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servicer incurs the following expenses. First, the servicer typically needs to provide advance monthly payments to the mortgage holder, even if the borrower stops making payments,[7] and the servicer needs to make such advance payments until the mortgage is terminated, namely, until a foreclosure or mortgage modification is completed. Second, the servicer needs to pay third parties for default services, such as title searches, drive-by inspections, and foreclosure fees. Taxes and insurance costs are also often advanced. When the servicer is liquidity constrained, these advances encourage the servicer to foreclose rather than modify the mortgage because foreclosure enables the servicer to obtain compensation for the advances more quickly than does modification: once a foreclosure sale is completed, the servicer receives immediate compensation for the advances it paid because the proceeds from a foreclosure sale are used to pay the expenses incurred, including payments advanced, by the servicer before being transferred to the mortgage holders. By contrast, it is difficult for the servicer to obtain full compensation immediately after a modification agreement is reached. The servicer is only compensated for the advances from the monthly payments (and sometimes from only the principal payments) of the modified mortgage. Since these monthly payments are much smaller than the lump sum gained from foreclosure, it takes much longer for the servicer to be repaid for its expenses. During the financial crisis, the affected financial institutions were seriously liquidity constrained, so they preferred foreclosure to modification even if it might have been beneficial for servicers to modify the loan in the long run. Therefore, a liquidity shock has a large impact on a servicer's propensity to modify mortgages. The empirical results presented in Section 4.1 show that the modification rate decreased sharply at the onset of the financial crisis.

[7] In most cases, servicers are required to advance interest on delinquent mortgages, although whether a principal balance is advanced depends on the Pooling and Servicing Agreement (PSA) (Thompson (2011)).

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2.3. TARP and Modification

In response to the subprime crisis, the Emergency Economic Stabilization Act was enacted on October 3, 2008, to authorize the U.S. Secretary of the Treasury to bailout banks via TARP. As part of TARP, the Treasury announced that it would make $250 billion available to U.S. financial institutions through purchases of preferred stock. In the end, TARP invested $204.9 billion in the financial system.

Through TARP, the government purchased equity (typically preferred stocks with warrants) from financial institutions in order to infuse capital. When the economy and these financial institutions recovered, the assisted financial institutions repaid the Treasury by repurchasing that equity and assets to exit the program. By June 10, 2013, financial institutions had received approximately $204.9 billion through this program, and $191.6 billion had been repaid through repurchases.[8] The sizable capital injection provided liquidity to the recipients: Through TARP, the government purchased newly issued preferred stocks with a vast amount of funds, which then became the banks' liquid assets.

The tremendous liquidity infusion provided by TARP dramatically alleviated the aforementioned servicers' liquidity constraints. Therefore, based on the preceding analysis, this liquidity injection should increase servicers' willingness to modify delinquent mortgages. However, it is also possible that TARP did not increase modification rate. One could argue that when a liquidity-constrained servicer receives a modification application, it can choose to modify the loan and encourage the borrower to start paying again. In this case, the servicer suffers from the much slower process of obtaining compensation for what they have advanced (normally, the

[8] See *Troubled Asset Relief Program (TARP) Monthly Report to Congress, June 2013.*

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servicer makes advance payments for several months before making a modification decision).[9] However, the servicer no longer needs to advance principal and interest payments if the borrower resumes payment on the loan. The servicer may be willing to avoid further advances at the cost of a slow compensation process. If so, then liquidity constraints from the crisis did not impede modification; hence, TARP would not increase modification rates. Ultimately, whether TARP increased the modification rate is an empirical question. This is the main question we investigate in this paper. Note that the objective of TARP was to infuse capital into the banking system rather than to promote mortgage modification. However, due to the importance of modification, as discussed in Section 1 and Section 2.1, studying the effects of TARP on modification, regardless of the primary aim, may yield important policy implications.

2.4. Comparison with HAMP

One government program specifically aimed to increase the modification rate of delinquent mortgages: HAMP. This program was announced on February 19, 2009. HAMP had some restrictions on eligible loans: the outstanding principal balance was no more than $729,750; the loan was originated no later than January 1, 2009; the house was an owner-occupied single-family home and the borrower's primary residence; and the debt-to-income ratio was higher than 31%. Agarwal et al. (2012) find that the overall impact of the program is substantially limited in the sense that it induced renegotiations for merely one-third of the 3 to 4 million indebted households targeted.

HAMP was characterized by its incentive payment structure. This program provided funds to mortgage borrowers, holders, and servicers to encourage them to modify mortgages. Servicers received an upfront fee of $1,000 for each completed permanent modification and an annual pay-

[9] In our sample, the average time before modification is 4.12 months.

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for-success fee of $1,000 for up to three years if mortgage payments were made on time.[10] This payment structure differed from that of TARP in two respects. First, in HAMP, each payment was made upon the success or continuation of the loan modification, so HAMP provided direct incentives for modification. However, in TARP, the government provided a lump-sum payment to recipients with little supervision and few requirements for the use of this funding. Second, in HAMP, payments were to be made for up to five years after a home affordable modification began (Thompson 2011). This post-modification payment did not substantially improve a servicer's liquidity, and liquidity-constrained servicers did not have adequate funding to offset the expense of modifications. By contrast, funding from TARP provided one-time liquidity infusions into the financial system, dramatically enhancing the liquidity of servicers and increasing servicers' propensity to modify mortgages.

3. Data and Methodology

3.1. Data Source

This paper exploits a dataset containing micro-level information about residential mortgages in the U.S. market. The mortgages included in this dataset are fully documented, fully amortizing, fixed-rate, single-family mortgages acquired by Fannie Mae. They were originated after January 1, 1999, with performance information through December 31, 2012. The original loan terms are between 25 and 35 years. This dataset does not include government-insured mortgages, mortgages with prepayment penalties, Home Affordable Refinance Program (HARP) mortgages, adjustable-rate mortgages, interest-only mortgages, or balloon mortgage. In total, there are 20 million loans in this dataset.

[10] Mortgage holders would receive a similar type of incentive. See Agarwal et al. (2012).

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This dataset contains both mortgage origination and performance information. First, it provides information about loan characteristics. We know the loan amount, interest rate, loan term, occupation status of the house during the loan period, borrower debt-to-income ratio, borrower FICO score, and LTV at origination. The location of the property is also provided. In addition, we have information about loan performance. The dataset tracks mortgage performance after origination, and the performance data are collected monthly. For each month, this dataset reports the outstanding balance on the loan, remaining months to maturity, servicer name and other information. Moreover, the performance dataset includes information on whether a mortgage becomes delinquent and on how long the mortgage has been delinquent. It also includes the date of modification and the change in the interest rate, outstanding balance, and remaining terms. Therefore, we can accurately identify whether a mortgage has been modified during its tenure.

3.2. Sample Construction

We analyze mortgages in default to determine how liquidity infusion affects mortgage modification. Following the literature on mortgages, we define default as a loan that is 60+ days past due. We focus on first-time defaults and the modification information from the performance data. We exclude loans that are modified when payments are current because modified loans may be less likely to be modified again. Then, we match the origination information of each loan in default to its performance data using a unique loan identifier. As a result, we obtain a cross-sectional dataset of all mortgages in default, and each observation includes information on loan characteristics, delinquency, and modification.

Over the entire repayment period, the servicer of a loan may change, so the servicer when a loan is modified or liquidated might differ from that at loan origination. One advantage of this

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dataset is that it has dynamic information on servicers, so they can be accurately identified each month. Additionally, the Department of the Treasury reports the details on TARP, including purchase dates, repayment dates, bailout amounts, and names of recipients. If a servicer or its parent company received TARP funding, we consider the servicer to have been assisted be the program.

3.3. Methodology

To assess the impact of TARP on modification, we need to estimate the counterfactual level of modification in the absence of the program. We construct treatment and control groups and use a difference-in-difference strategy. If a servicer or its parent company was on the bailout list, then the servicer was exposed to TARP, and the corresponding mortgages are included in the treatment group. Mortgages whose servicers were not exposed to TARP serve as controls.

We use the following logistic specification to estimate the effects of TARP on mortgage modification:

$$Pr(Y_i=1)=\Phi\,(\alpha + \beta * T_i + \gamma * tptime_i + \eta * T * tptime_i + \Sigma\lambda_{ij} * z_{ij} + \varepsilon_i), \quad (1)$$

where $\Phi(x)=\exp(x)/(1+\exp(x))$.

Note that all mortgages in our sample are 60+ days delinquent. The dependent variable Y_i equals 1 if the delinquent loan was modified and 0 otherwise. T takes the value 1 if the loan is in the treatment group and 0 otherwise. The variable *tptime* measures whether the borrower defaulted within the TARP period, taking the value 1 if the default occurred after October 14, 2008, which marks the beginning of TARP, and before April 1, 2011, when most bailed-out banks had quit TARP. *T*tptime* is an interaction between *T* and *tptime*, and this is the variable of interest.

The coefficient β measures the pre-program differences between treatment and control

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groups. The coefficient γ captures the effects of all factors except TARP and is correlated to the TARP period of mortgage modification. It measures the change in the modification rate from the treatment period to the non-treatment period (the pre-treatment and post-treatment periods) that was not caused by TARP but by other event that happened at the same time. The coefficient η measures the effect of TARP.

z_{ij} includes a series of control variables. We control for loan characteristics, including interest rate, natural logarithm of original balance, FICO score, LTV at origination, mark-to-market LTV, debt-to-income ratio, multiple liens (whether the loan has a second lien), occupation status, loan age, and HAMP eligibility.[11] We also control for origination channel, Metropolitan Statistical Area (MSA), servicer, and origination year fixed effects. We include a vector of time dummies for every quarter of every year in which the borrowers default. Robust standard errors are clustered at the servicer level.

One concern is that servicers can be banks or non-bank servicers. Since TARP targeted banks, non-bank servicers did not receive TARP funding, and loans serviced by non-bank servicers are more likely to be included in the control group. In addition, there are unobserved differences between banks and non-bank servicers since their main business is different. Therefore, it is possible that the difference between banks and non-bank servicers drives the results. To address this concern, we remove all non-bank servicers, which account for 12.5% of all servicers. Overall,

[11] Following Agarwal et al. (2011), we discretized the mark-to-market LTV and FICO scores into buckets. The mark-to-market LTV buckets are (1) ≤30%, (2) >30% to 40%, (3) >40% to 50%, (4) >50% to 60%, (5) >60% to 70%, (6) >70% to 80%, (7) >80% to 90%, (8) >90% to 100%, (9) >100% to 110%, (10) >110% to 120%, (11) >120% to 135%, (12) >135% to 150%, and (13) 150%+. The FICO score buckets are (1) ≤640, (2) >640 to 670, (3) >670 to 700, (4) >700 to 740, and (5) 740+.

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84.6% of bank servicers received TARP bailout funds.

4. Empirical Analysis

4.1. Modification Rates for the Treatment and Control Groups

Before rigorously testing the effects of the bailout on modification, we examine the trends in modification rates for the treatment group and the control group. We compute the modification rate (the number of mortgages modified in a given quarter divided by the number of delinquent mortgages outstanding in that quarter) for every quarter of every year from the first quarter of 2007 to the second quarter of 2012 and construct a time series. The results are displayed in Figure 1. Before the financial crisis, the modification rate of the treatment group was consistently lower than that of the control group. From the first quarter to the second quarter of 2008, shortly after the financial crisis began, the modification rates for both groups decreased sharply. This pattern is consistent with the argument presented in Section 2.2 that liquidity constraints seriously inhibit a servicer's propensity to modify mortgages.[12]

[Insert Figure 1 About Here]

Capital purchases through TARP began in late 2008, and the first round of TARP recipients received bailouts on October 14, 2008. From the fourth quarter of 2008 to the first quarter of 2009, the modification rate of the treatment group began to recover, while that of the control group remained flat.[13] The difference in the modification rate between the treatment group and the

[12] In Section 5.3, we consider increasing the number of delinquencies and rigorously analyze how TARP affects the modification rates.

[13] Later, the modification rate of the control group also increased because of HAMP, which affected both the treatment group and the control group.

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control group grew until the third quarter of 2010. Then, the modification rate for the treatment group gradually decreased; during this period, the assisted banks exited TARP in sequence as they repurchased their equity from the Treasury. Note that from the fourth quarter of 2008 to the fourth quarter of 2010, the modification rate of the treatment group was consistently higher than that of the control group, in sharp contrast to the periods before the crisis and after exiting TARP.

The dynamics of the modification rates for the treatment and the control groups imply that the liquidity infusion from TARP might have had a substantial impact on mortgage modification. In Section 4.3, we exploit the method described in Section 3.3 to rigorously analyze the effects of liquidity infusions on modification.

4.2. Summary Statistics for the Treatment and Control Groups

In this section, we compare the quality of mortgages in the treatment and control groups to show that the two groups are comparable. Table 1 displays descriptive statistics for the loan characteristics of the treatment and control groups. In total, there are 760,222 observations. The means and standard deviations of the loan characteristic variables of the treatment and control groups are very similar despite some tiny differences. To display the distribution of loan characteristics for the two groups, in Figure 2, we plot the kernel densities of the interest rate, LTV, original loan balance, debt-to-income ratio, FICO score, and original loan term for mortgages in the treatment and control groups. The treatment group is represented by the solid line, and the control group is represented by the dashed line. Mortgages in treatment and control groups look similar along all these dimensions. Specifically, the interest rate that captures the overall riskiness of the mortgage is very similar in both groups. The debt-to-income ratio, which measures mortgage affordability to borrowers, is similar across these two groups. The original

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loan term clusters at 360 months, since all loans in our sample are 30-year mortgages.[14] This analysis suggests that there are few differences in the loan characteristics of the treatment and control groups.

[Insert Table 1 About Here]

[Insert Figure 2 About Here]

4.3. The Effects of TARP on Loan Modification

We follow the difference-in-difference approach introduced in Section 3.3 to analyze the effects of TARP on loan modification. First, we conduct difference-in-difference analyses with and without considering loan characteristics. Columns (1) and (2) in Panel A of Table 2 display the results. The estimate of the odds ratio of *T*tptime* indicates that TARP has a statistically significant positive effect on mortgage modification. Moreover, after controlling for loan characteristics, the odds ratio is still larger than 1 (1.517), indicating that the results are not driven by loan characteristics.

[Insert Table 2 About Here]

Then, we restrict our sample to HAMP eligible loans, which account for 89.47% of the full sample and control for the HAMP period. This restriction makes the loans more homogeneous, and since all loans in our sample are HAMP loans, the effect of HAMP can be disentangled from the effect of TARP by the coefficient of the HAMP period. There are other stimulus programs, such as quantitative easing (QE). These programs affect both the treatment and control groups and do not affect our estimation, since we use a difference-in-difference specification. Column (3) in

[14] In the industry, a "30-year" mortgage refers to a mortgage with an original term of more than 25 and up to 30 years.

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Panel A of Table 2 displays the results.[15] The odds ratio is approximately 1.483; thus, a liquidity injection from TARP makes mortgages 48.3% more likely to be modified. This is a substantial impact and is consistent with the pattern in Figure 1.[16]

We test whether the results are robust to different functional forms. We first exclude the servicer fixed effects and the time fixed effects from the regression. The estimate of the *T*tptime* interaction term still indicates a positive effect (Columns (4) of Panel A in Table 2). We also estimate a linear probability model and compare the marginal effect to that of the logit model. The coefficients are reported in Column (5) of Panel A in Table 2.[17] The coefficient of *T*tptime* is 0.0773, and the modification rate for the control group is 0.200 (Table 1), so the marginal effect is that mortgages are 38.65% more likely to be modified. The marginal effects from the logit model and the linear model are comparable.

We then exclude bailout recipients who exited TARP after April 1, 2011, and re-estimate the difference-in-difference equation (Column (1) in Panel B of Table 2), since most bailed-out banks had exited TARP by then. We also consider a continuous difference-in-difference specification (Column (2) in Panel B of Table 2). Instead of the bailout recipient dummy *T,* we use the amount of bailout, with billions of dollars as the unit. Therefore, we replace *T** with

[15] In this sample, there is no variation in occupation status because we restrict our sample to HAMP loans, which requires that properties be owner occupied.

[16] Hereafter, we consider only HAMP-eligible loans in the modification analysis.

[17] The number of observations in Column (3) is slightly lower than in Column (5) because we control for several fixed effects. Some groups (for instance, mortgages within certain mark-to-market LTV buckets) do not include defaults and have no dependent variable variation. Therefore, observations in these groups are dropped. This also occurs with other pairs of regressions in this paper that use the same sample but different model specifications.

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the amount of the bailout received by each bank and *T*tptime* with the interaction between the bailout amount and the treatment period dummy in the regression. The odds ratios of the interaction term in both tests are still larger than one and consistent with our hypothesis.

Deposit inflows may also affect banks' liquidity. We collected data on the ratio of deposits to total assets for each bank in each quarter and year to measure deposit inflows. We then control for this deposit measure and find that while deposit inflows have positive effects on modification, the *T*tptime* estimates change only slightly (Column (3) in Panel B of Table 2). The estimates suggest that the results for TARP are not due to deposit inflows. We also control for a dummy indicating whether the loan is serviced by its originator. We observe the seller of each loan (i.e., the bank that sold the loan to Fannie Mae) and use this as a proxy for the originator, since loans are normally sold by the originator to Fannie Mae. We define an originator dummy that equals 1 if the originator and the servicer of a loan are the same bank and 0 otherwise. We find that the effects of the originator are statistically insignificant and the estimates of *T*tptime* change only slightly (Column (4) in Panel B of Table 2).

5. **Robustness Tests**

5.1. Placebo Tests

We conduct two placebo tests to gauge the validity of our results. First, we randomly select some bank servicers and consider them TARP bailout recipients to construct a new sample, with the proportion of the recipients in this sample equivalent to that of the original sample described in Section 4.3. We then re-estimated the difference-in-difference specification using the new sample. Since the treatment group is randomly assigned, the estimates of the interaction term *T*tptime* should be statistically insignificant. We repeat this process one hundred times

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and obtain one hundred estimates for the *T*tptime* interaction term. Then, we conduct a t-test and find that the coefficient of the interaction term is statistically indistinguishable from zero. The results of the t-test are in Panel B of Table 3.

Second, we limit the observations to loans that became delinquent before TARP, assuming that TARP starts between 2002 and 2008, and redefine the treatment period and interaction term accordingly. Therefore, we obtain seven samples with pseudo-treatment periods for which the estimates of the *T*tptime* interaction term are supposed to be statistically insignificant. Using these samples, we re-estimate the difference-in-difference specification and find that the coefficient of *T*tptime* is statistically insignificant for any one sample. Panel A of Table 3 displays the results.

[Insert Table 3 About Here]

5.2. Initial TARP Recipients

It is possible that the banks in the treatment group chose to take TARP funds, whereas banks in the control group chose not to. If banks that were planning to modify a large fraction of their loans chose to take TARP funds, our conclusions would be invalid. To address the issue, we consider the initial TARP recipients: on October 14, 2008, nine financial institutions received bailouts for TARP; they were forced to participate rather than able to participate in TARP (Veronesi and Zingales (2010). Therefore, we include only the initial TARP recipients in the treatment group and re-estimate the logit specification. Table 4 shows the results. The odds ratio is 1.586, supporting the positive effect of TARP on loan modification.

[Insert Table 4 About Here]

5.3. Changes in the Default Rate

If the default rate increases very quickly, the modification rate will tend to decrease because

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it takes time for servicers to adapt to a higher default rate by training new staff and upgrading their computer systems. Thus, there is a concern that the difference in the evolution of modification rate between the treatment and control groups stems from changes in the default rates faced by servicers in the treatment and control groups. To alleviate this concern, we construct quarterly first-differenced time series of default rates for *each servicer* to measure the change in the default rate. We match this first-differenced time series to the main dataset by the servicer and re-estimate the specification in Column (3) of Table 2 controlling for changes in the default rate. Table 5 presents the results. The odds ratio indicates that after taking the default rate into account, the effect of TARP on modification are still significant and positive.

[Insert Table 5 About Here]

5.4. Judicial and Non-judicial Foreclosure

In this section, we exploit variation in the foreclosure process across states to rule out alternative explanations. In some states, judicial foreclosure is required: the process occurs under court supervision and takes much longer than non-judicial foreclosure. This paper assumes that recouping the funds advanced to investors takes longer through modification than through foreclosure; therefore, modification requires more liquidity, and TARP alleviates this problem. However, in judicial foreclosure states, even if delinquent loans end up in foreclosure, it still takes much more time for servicers to obtain compensation for advances. Therefore, the difference in the liquidity requirements for foreclosure and modification is smaller in states with judicial foreclosure than in states with non-judicial foreclosure. If the effect we observed in Section 4.3 is due to improved liquidity, we should obtain larger effects for non-judicial foreclosure states than for judicial foreclosure states.

We divide the full sample into two subsamples consisting of loans from judicial and non-

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judicial foreclosure states and re-estimate the difference-in-difference specification. Table 6 presents the results. The odds ratio for non-judicial foreclosure (Column (1)) is statistically significant and much larger than that for judicial foreclosure (Column (2)). We also define a *judicial* dummy that equals 1 if the loan is from a judicial foreclosure state and 0 otherwise. We add this *judicial* dummy and its interaction with *T*tptime, T*tptime*judicial*, into the regression and re-estimate the model (Column(3)). The estimates of *T*tptime*judicial* are lower than one, while the estimates of *T*tptime* remains above one. The results confirm that the effects of TARP on loan modification are smaller in states with judicial foreclosure. Overall, the results are consistent with our hypothesis.

[Insert Table 6 About Here]

6. The Liquidity Channel

The key argument in this paper is that TARP increases modification rates through liquidity injection. In this section, we provide an additional test to validate this argument. We control for the servicers' liquidity conditions in the difference-in-difference specification and consider how the estimates of *T*tptime* change. If liquidity plays a role in the effects of TARP on modification, then the estimates of *T*tptime* should change.

Based on data availability, we use two measures of banks' liquidity conditions: The ratio of liquid assets to total assets and the ratio of liquid assets to total liabilities.[18] The amount of liquid assets is the sum of cash and balances due, securities, Fed funds sold and repos, and trading account assets minus pledged securities. First, we control for the ratio of liquid assets to total assets and re-estimate the difference-in-difference specification in equation (1). The results presented are in Column (2) of Table 7. For comparison, we include the results of the baseline

[18] These two measures are directly downloaded from the dataset maintained by SNL Financial.

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specification in Column (1) (same as Column (3) in Table 2). The marginal effects decrease from 48% to 21% (by 56% in relative terms), while the R-squared does not change (remains at 0.142). The test in Column (4) shows that this decrease is significantly different from zero. The results are similar when we use the ratio of liquid assets to total liabilities to measure liquidity conditions (Columns (3) and (5) of Table 7). The results indicate that a substantial share of the effects of TARP on modification occur through liquidity injection. Note that we do not wish to eliminate the possibility that there are other channels through which TARP affects modification; rather, we conjecture that regardless of whether there are other channels (the 44% part), this liquidity channel exists (the 56% part).

[Insert Table 7 About Here]

7. Further Tests

7.1. Horizon

We also investigate whether the effects of TARP are sensitive to the horizon over which mortgages are modified. In the baseline specification in Section 4.3, modification can happen at any time after borrower default. Now, we consider modifications within three-month delinquency and six-month delinquency. The results are presented in Table 8. The odds ratio for the three-month period (Column(1)) is insignificant, while the odds ratio for six-month period (Column(2)) is significant. The test in Column (3) suggests that the difference in the odds ratio between the two specifications is significantly different from zero. The results suggest that TARP mainly promotes modification after a longer period of delinquency.

[Insert Table 8 About Here]

7.2. The Risk of Modified Loans

We also test whether servicers choose to modify riskier or safer loans after TARP. We restrict

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the sample to modified loans and use FICO score, mark-to-market LTV when the borrowers default, and interest rate to measure loan risk. Then, we estimate a similar difference-in-difference regression as in equation (1), with the main difference being that the dependent variable is the loan risk measure. The results are displayed in Table 9. The coefficient of the interaction term *T*tptime* is insignificant no matter which loan risk measure we use. Therefore, we did not find any evidence that modification after TARP is conducted on either riskier or safer loans.

Note that our results do not conflict with the findings of a literature arguing that TARP increases bank risk-taking behavior (Duchin and Sosyura, 2014; Acharya and Yorulmazer, 2007). Modification is not necessarily a risk-taking behavior because servicers will ultimately be reimbursed for advances regardless of whether the modified loans defaulted again.

[Insert Table 9 About Here]

7.3. Intensive Margin

So far, we have shown that the TARP has a significant positive impact on the likelihood of modification. Next, we explore whether the liquidity infusion affects the extent to which mortgages are modified.

Mortgages can be modified in different dimensions. First, the interest rate may be reduced. Second, the term may be extended to reduce the monthly payment. Third, a part of the principal may be written off.[19] Modification of these terms, individually or in combination, can change the borrower's monthly payment. Agarwal, Amromin, Ben-David, Chomsisengphet, and Evanoff (2010) find that affordability is the prime reason for redefault following modification. Therefore,

[19] However, the balance usually increases because unpaid interest is capitalized.

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we test whether a monthly payment reduction is affected by a liquidity infusion, conditional on the mortgage being modified.

In our dataset, we can observe changes in interest rates and maturity dates (terms). We cannot observe whether a mortgage receives a principal write-down, but we can observe the change in balance as a result of the capitalization of unpaid interest and a principal write-down. Then, we compute the monthly payment amount before and after modification, subtract the new monthly payment from monthly payment prior to modification, and divide this difference by monthly payment before modification. If this value is positive, then the monthly payment is reduced. The larger the value, the larger the reduction. In our sample, the monthly payment was reduced by 11.13%, on average.

We then regress the monthly payment reduction on *T*tptime* and other control variables using generalized least squares estimation. The regression is conditional on mortgages receiving certain types of modifications. Table 10 presents the results.

The coefficient of *T*tptim*e is statistically but not economically significant: TARP leads to a 1.63 percentage point change in the monthly payment. This effect is small perhaps because Fannie Mae provides clear and specific instructions regarding mortgage modification for servicers to follow, and the specific terms of modification are thus not likely to be affected by external factors.

[Insert Table 10 About Here]

8. Conclusion

In this paper, we use a residential mortgage dataset containing detailed information on mortgage modification to explore the effects of government bailouts on the likelihood of modification. We find that liquidity infusions from TARP substantially increased the likelihood of modification. We argue that liquidity infusions alleviated servicers' liquidity constraints and

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made them more willing to modify mortgages.

This study is the first to provide empirical evidence that liquidity enhancement plays a role in encouraging mortgage modification. Second, it shows that government bailouts positively affect mortgage modification and adds on to the literature on government intervention. In addition, this paper emphasizes the importance of liquidity in the financial system.

It is straightforward that when modification rates are low, we need to consider improving servicer's liquidity. TARP infused liquidity into banks, but servicers did not directly benefit from this infusion, since some of them were subsidiaries of these banks. Direct liquidity infusions for servicers might have a greater impact. An alternative is to intervene in the PSA such that the liquidity of servicers does not affect modification. However, such a policy change may lead to other reactions and requires further analysis. This is a fruitful area for future research.

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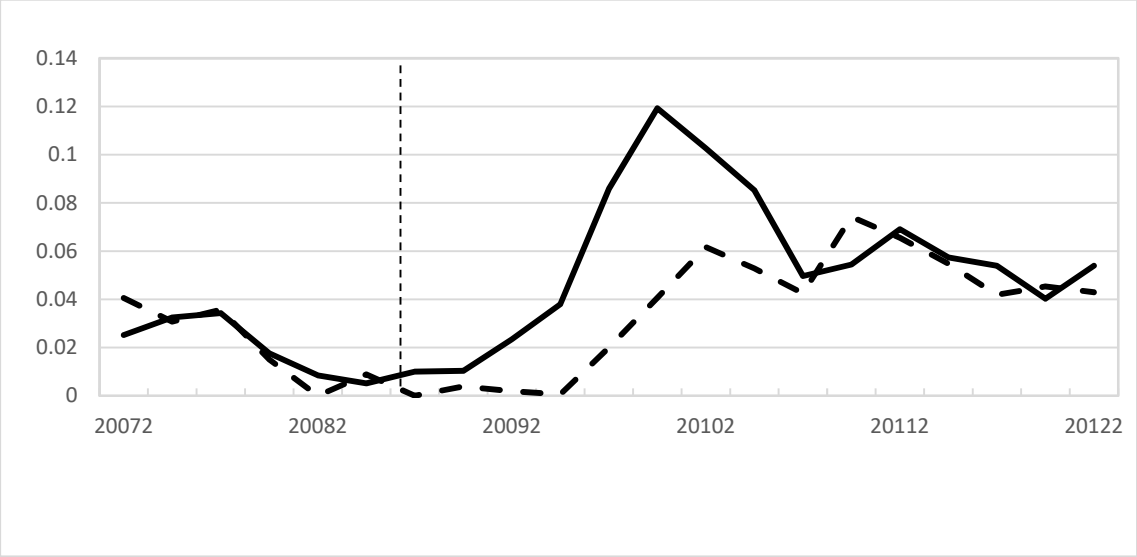
Figure 1 Time Series of the Modification Rate



Notes: This figure shows how the modification rate evolves over time for the treatment group and the control group. The treatment group is represented by the solid line, and the control group is represented by the dashed line. The modification rate is the number of mortgages modified in a given quarter divided by the number of delinquent mortgages outstanding in that quarter for every quarter of every year from the first quarter of 2007 to the second quarter of 2012. The vertical dashed line indicates the beginning of TARP.

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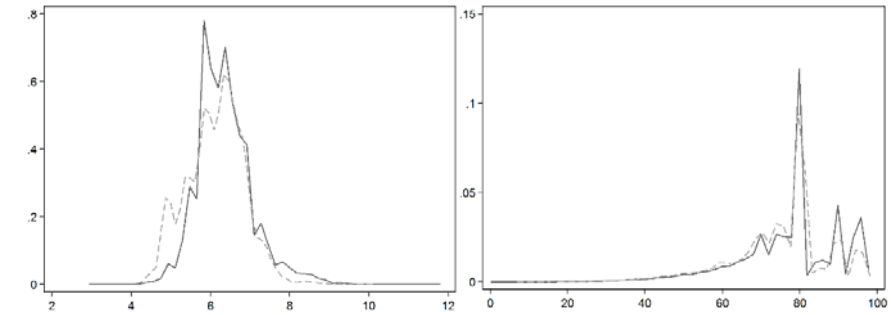
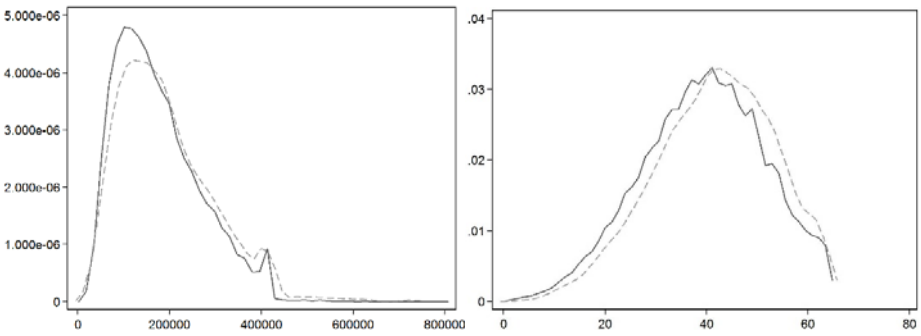
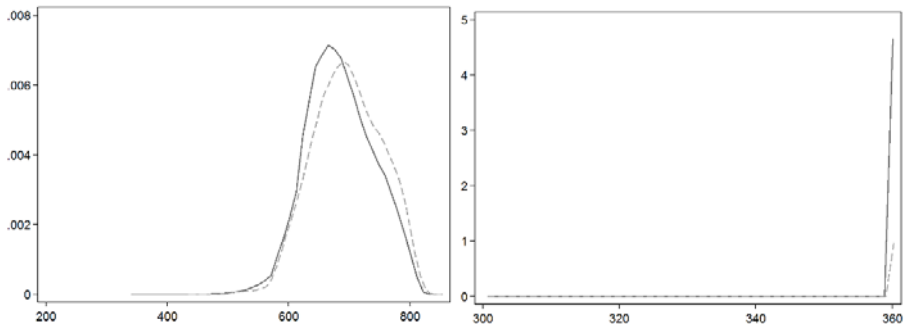
Figure 2: Comparability of Treatment and Control Groups – Kernel Densities of Observables



(a) Interest Rate **(b) LTV**



(c) Original Balance **(d) Debt-to-Income Ratio**



(e) FICO Credit Score **(f) Original Term**

Notes: This figure shows the kernel density plots for the original interest rate (Figure (a)), LTV (Figure (b)), original balance (Figure (c)), debt-to-income ratio (Figure (d)), FICO credit score (Figure (e)), and term (Figure (f)). The treatment group is represented by the solid lines, and the control group is represented by the dashed lines.

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Table 1 Summary Statistics for Treatment and Control Groups

	Treatment obs=750353		Control obs=9869	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Modification	0.228	0.420	0.200	0.400
Interest rate (%)	6.344	0.709	6.119	0.720
LTV (%)	77.267	13.193	75.016	12.971
Original balance	175190.600	92843.730	193166.100	104560.900
Debt-to-income ratio (%)	39.248	12.089	41.557	11.704
FICO	684.725	55.141	696.553	56.276
Original term	359.960	0.955	359.889	1.859

Notes: This table compares the characteristics of the treatment group and the control group. If mortgage servicers or servicer parent companies are on the TARP bailout list, then the corresponding mortgages are included in the treatment group. Mortgages whose servicers are not exposed to TARP serve as the control group. *Modification* is a dummy variable that equals 1 if the delinquent mortgage is modified and 0 otherwise.

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Table 2 Effects of TARP on Modification

Panel A

Dependent Variable: Modification dummy					
	(1)	(2)	(3)	(4)	(5)
	Drop loan characteristics	Baseline	HAMP-eligible loans only	Drop treatment group and treatment period dummy	Least squares regression
T*tptime	1.633***	1.517***	1.483***	1.736***	0.0773***
	(7.78)	(6.51)	(6.14)	(8.96)	(7.39)
tptime	0.699***	0.742***	0.768***	1.050	-0.0551***
	(-4.96)	(-4.07)	(-3.57)	(0.68)	(-4.60)
T	2.275***	1.702***	1.781***	1.058	0.0420***
	(4.30)	(2.84)	(2.89)	(1.02)	(4.05)
HAMP time			3.453***	1.724***	0.0971***
			(7.39)	(24.92)	(5.53)
Interest rate		1.022*	1.018	0.935***	0.0058***
		(1.78)	(1.51)	(-5.96)	(3.24)
Log original loan balance		1.719***	1.733***	1.790***	0.0774***
		(22.96)	(21.40)	(22.86)	(16.99)
LTV		0.992***	0.992***	0.992***	-0.0018***
		(-8.73)	(-8.30)	(-9.33)	(-9.73)
Debt-to-income ratio		1.012***	1.012***	1.012***	0.0018***
		(23.14)	(22.32)	(22.42)	(13.89)
Loan age		1.003***	1.002**	1.004***	0.0008***
		(2.80)	(2.53)	(3.83)	(4.26)
Multiple lien		0.844***	0.838***	0.857***	-0.0291***
		(-6.71)	(-7.04)	(-5.90)	(-5.87)
Occupation status		0.530***			
		(-17.55)			
HAMP eligibility	2.611***	1.587***			
	(23.99)	(18.97)			
Fixed effects:					
Origination channel	No	Yes	Yes	Yes	Yes
FICO buckets	No	Yes	Yes	Yes	Yes
Mark-to-market LTV buckets	No	Yes	Yes	Yes	Yes
MSA	Yes	Yes	Yes	Yes	Yes
Servicer	Yes	Yes	Yes	No	Yes
Origination year	No	Yes	Yes	Yes	Yes
Delinquency quarter*year	Yes	Yes	Yes	No	Yes
Pseudo R-squared	0.120	0.145	0.142	0.128	0.144

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Observations	760186	760186	680120	680120	680153

Panel B

Dependent Variable: Modification dummy				
	(1)	(2)	(3)	(4)
	Exclude recipients who exited after April 2011	Continuous Diff-in-Diff	Control for deposits	Control for originator
T*tptime	1.453***		1.542***	1.482***
	(5.85)		(6.72)	(6.14)
tptime	0.786***	0.885***	0.739***	0.769***
	(-3.29)	(-3.97)	(-4.06)	(-3.56)
T	1.912***		1.667**	1.796***
	(3.25)		(2.53)	(2.92)
Bailout amount*tptime		1.013***		
		(13.80)		
Bailout amount		1.011***		
		(2.86)		
Deposits/assets			1.031***	
			(8.43)	
Originator				1.010
				(0.81)
HAMP time	3.288***	3.292***	3.144***	3.447***
	(6.90)	(7.09)	(6.71)	(7.39)
Interest rate	1.018	1.019	1.018	1.019
	(1.46)	(1.54)	(1.50)	(1.52)
Log original loan balance	1.734***	1.734***	1.733***	1.732***
	(21.46)	(21.54)	(21.40)	(21.40)
LTV	0.992***	0.992***	0.992***	0.992***
	(-8.31)	(-8.29)	(-8.33)	(-8.32)
Debt-to-income ratio	1.012***	1.012***	1.012***	1.012***
	(22.32)	(22.35)	(22.34)	(22.79)
Loan age	1.002***	1.002**	1.002**	1.002**
	(2.63)	(2.48)	(2.50)	(2.53)
Multiple lien	0.838***	0.838***	0.838***	0.838***
	(-7.03)	(-7.05)	(-7.06)	(-7.04)
Fixed effects:				
Origination channel	Yes	Yes	Yes	Yes
FICO buckets	Yes	Yes	Yes	Yes
Mark-to-market LTV buckets	Yes	Yes	Yes	Yes
MSA	Yes	Yes	Yes	Yes
Servicer	Yes	Yes	Yes	Yes
Origination year	No	Yes	Yes	Yes

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Delinquency quarter*year	Yes	Yes	Yes	Yes
Pseudo R-squared	0.142	0.142	0.142	0.142
Observations	679460	680120	680095	680120

Notes: This table presents the logistic and least-squares regressions of the modification dummy on TARP and other variables. The dependent variable is an indicator that equals 1 if the delinquent loan is modified after the borrower defaults and 0 otherwise. *tptime* measures whether the borrower defaulted during the TARP period. *T*tptime* measures whether loans are exposed to TARP. The specific method used to construct *tptime* and *T*tptime* is introduced in Section 3.3. *T* takes the value of 1 if a loan comes from the treatment group and 0 otherwise. We control for loan characteristics and a series of fixed effects. Robust standard errors are clustered at the servicer level. Robust z-statistics are reported in parentheses. Odds ratios are reported to measure marginal effects. *, ** and *** indicate significance at the 10 percent, 5 percent and 1 percent levels, respectively.

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Table 3 Placebo Tests

Panel A

Dependent Variable: Modification dummy							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Starting year of treatment period	2002	2003	2004	2005	2006	2007	2008
T*tptime	1.743	0.713	0.867	0.867	0.867	1.954	1.311
	(0.49)	(-0.31)	(-0.13)	(-0.13)	(-0.13)	(1.08)	(0.36)
tptime	0.425	1.367	1.183	1.032	1.051	0.578	0.852
	(-0.79)	(0.28)	(0.16)	(0.03)	(0.05)	(-0.87)	(-0.21)
T	1.280	2.939	2.231	2.231	2.231	2.229	2.232
	(0.16)	(0.86)	(0.84)	(0.84)	(0.84)	(0.84)	(0.84)
Interest rate	1.021	1.021	1.021	1.021	1.021	1.021	1.021
	(1.09)	(1.10)	(1.11)	(1.10)	(1.10)	(1.12)	(1.12)
Log original loan balance	1.433***	1.433***	1.433***	1.433***	1.433***	1.433***	1.433***
	(10.03)	(10.03)	(10.03)	(10.03)	(10.04)	(10.03)	(10.02)
LTV	0.992***	0.992***	0.992***	0.992***	0.992***	0.992***	0.992***
	(-4.57)	(-4.57)	(-4.56)	(-4.57)	(-4.57)	(-4.56)	(-4.56)
Debt-to-income ratio	1.008***	1.008***	1.008***	1.008***	1.008***	1.008***	1.008***
	(9.78)	(9.78)	(9.77)	(9.78)	(9.78)	(9.78)	(9.79)
Loan age	1.002*	1.002*	1.002*	1.002*	1.002*	1.002*	1.002*
	(1.95)	(1.94)	(1.94)	(1.94)	(1.94)	(1.92)	(1.92)
Multiple lien	0.923**	0.923**	0.923**	0.923**	0.923**	0.923**	0.923**
	(-2.11)	(-2.11)	(-2.11)	(-2.11)	(-2.11)	(-2.11)	(-2.12)
Fixed effects:							
Origination channel	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FICO buckets	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mark-to-market LTV buckets	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MSA	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Servicer	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Origination year	No	Yes	Yes	Yes	Yes	Yes	Yes
Delinquency quarter*year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R-squared	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Observations	239764	239764	239764	239764	239764	239764	239764

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Panel B

Dependent Variable: Modification dummy	
*T-test for the coefficient of T*tptime*	
Mean	0.004753
t-statistics	(0.21)
Pr(|T| >|t|)	0.833
All loan characteristics and fixed effects controlled for and repeated 100 times.	

Notes: This table presents the logistic regressions of the modification dummy on TARP and other variables. The dependent variable is an indicator that equals 1 if the delinquent loan is modified after the borrower defaults and 0 otherwise. In Panel A, we randomly select one year from 2002 to 2008 and assume that it is the starting year of TARP. *tptime* measures whether the borrower defaulted in the pseudo-period of TARP. *T*tptime* measures whether loans are exposed to TARP. The specific method used to construct *tptime* and *T*tptime* is introduced in Section 3.3. *T* takes the value of 1 if a loan comes from the treatment group and 0 otherwise. We control for loan characteristics and a series of fixed effects. Robust standard errors are clustered at the servicer level. Robust z-statistics are reported in parentheses. Odds ratios are reported to measure marginal effects. *, ** and *** indicate significance at the 10 percent, 5 percent and 1 percent levels, respectively. In Panel B, we randomly select some bank servicers and consider them TARP bailout recipients, with the proportion of recipients in this sample unchanged compared with that of the original sample in Section 4.3. We then re-estimated the difference-in-difference specification using the new sample. We repeat this process one hundred times and obtain one hundred estimates for the T*tptime interaction term. Then, we conducted a t-test, and the results of the t-test are in Panel B. display the results in Panel B.

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Table 4 Initial TARP Recipients

Dependent Variable: Modification dummy	
	Initial TARP recipients
T*tptime	1.586***
	(7.25)
tptime	0.703***
	(-4.40)
T	0.770*
	(-1.96)
HAMP time	3.608***
	(5.13)
Interest rate	1.033**
	(2.50)
Log original loan balance	1.747***
	(19.73)
LTV	0.993***
	(-6.63)
Debt-to-income ratio	1.012***
	(21.24)
Loan age	1.001
	(0.92)
Multiple lien	0.810***
	(-7.40)
Fixed effects:	
Origination channel	Yes
FICO buckets	Yes
Mark-to-market LTV buckets	Yes
MSA	Yes
Servicer	Yes
Origination year	Yes
Delinquency quarter*year	Yes
Pseudo R-squared	0.133
Observations	426380

Notes: This table presents the logistic regression for Section 5.2. The dependent variable is an indicator that equals 1 if the delinquent loan is modified after the borrower defaults and 0 otherwise. *tptime* measures whether the borrower defaulted during the TARP period. *T*tptime* measures whether loans are exposed to TARP. The specific method used to construct *tptime* and *T*tptime* is introduced in Section 3.3. *T* takes the value of 1 if a loan comes from the treatment group and 0 otherwise. We control for loan characteristics and a series of fixed effects. Robust standard errors are clustered at the servicer level. Robust z-statistics are reported in parentheses. Odds ratios are reported to measure marginal effects. *, ** and *** indicate significance at the 10 percent, 5 percent and 1 percent levels, respectively.

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Table 5 Changes in Default Rate

Dependent Variable: Modification dummy	
	Consider default rate
T*tptime	1.453***
	(5.86)
tptime	0.785***
	(-3.31)
T	1.914***
	(3.26)
HAMP time	3.304***
	(7.07)
Interest rate	1.018
	(1.45)
Log original loan balance	1.733***
	(21.45)
LTV	0.992***
	(-8.31)
Debt-to-income ratio	1.012***
	(22.29)
Loan age	1.002***
	(2.65)
Multiple lien	0.838***
	(-7.05)
Change in default rate	1.325***
	(7.43)
Fixed effects:	
Origination channel	Yes
FICO buckets	Yes
Mark-to-market LTV buckets	Yes
MSA	Yes
Servicer	Yes
Origination year	Yes
Delinquency quarter*year	Yes
Pseudo R-squared	0.142
Observations	680120

*Notes:*This table presents the results of a robustness test considering changes in the default rate. The dependent variable is an indicator that equals 1 if the delinquent loan is modified after the borrower defaults and 0 otherwise. *tptime* measures whether the borrower defaulted during the TARP period. *T*tptime* measures whether loans are exposed to TARP. The specific method used to construct *tptime* and *T*tptime* is introduced in Section 3.3. *T* takes the value of 1 if a loan comes from the treatment group and 0 otherwise. We control for loan characteristics and a series of fixed effects. Robust standard errors are clustered at the servicer level. Robust z-statistics are reported in

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parentheses. Odds ratios are reported to measure marginal effects. *, ** and *** indicate significance at the 10 percent, 5 percent and 1 percent levels, respectively.

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Table 6 Judicial and Non-judicial

Dependent Variable: Modification dummy			
	(1)	(2)	(3)
	Non-judicial states	Judicial states	Full sample
T*tptime*judicial			0.920*
			(-1.94)
T*tptime	1.614***	1.339***	1.535***
	(6.07)	(2.82)	(6.24)
Judicial			1.214***
			(5.61)
tptime	0.705***	0.853	0.770***
	(-3.92)	(-1.36)	(-3.56)
T	1.561**	2.137*	1.783***
	(1.96)	(1.92)	(2.89)
HAMP time	3.760***	2.871***	3.412***
	(6.25)	(3.71)	(7.24)
Interest rate	1.019	1.014	1.018
	(1.38)	(0.84)	(1.51)
Log original loan balance	1.694***	1.788***	1.736***
	(21.04)	(13.20)	(21.38)
LTV	0.992***	0.992***	0.992***
	(-7.41)	(-8.13)	(-8.77)
Debt-to-income ratio	1.012***	1.011***	1.012***
	(17.79)	(15.30)	(22.42)
Loan age	1.001	1.005***	1.002***
	(0.85)	(3.91)	(2.65)
Multiple lien	0.812***	0.872***	0.838***
	(-7.89)	(-3.09)	(-7.04)
Fixed effects:			
Origination channel	Yes	Yes	Yes
FICO buckets	Yes	Yes	Yes
Mark-to-market LTV buckets	Yes	Yes	Yes
MSA	Yes	Yes	Yes
Servicer	Yes	Yes	Yes
Origination year	Yes	Yes	Yes
Delinquency quarter*year	Yes	Yes	Yes
Pseudo R-squared	0.145	0.140	0.142
Observations	395994	284097	680120

Notes: This table presents the results of a robustness test considering the effects of judicial foreclosure on modification. The dependent variable is an indicator that equals 1 if the delinquent loan is modified after the borrower defaults and 0 otherwise. *tptime* measures whether the borrower defaulted during the TARP period. *T*tptime* measures whether loans are exposed to TARP. The specific method used to construct *tptime* and *T*tptime*

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is introduced in Section 3.3. *T* takes the value of 1 if a loan comes from the treatment group and 0 otherwise. *T*tptime*judicial* measures how the effects of TARP on modification are effected by judicial foreclosure. We control for loan characteristics and a series of fixed effects. Robust standard errors are clustered at the servicer level. Robust z-statistics are reported in parentheses. Odds ratios are reported to measure marginal effects. *, ** and *** indicate significance at the 10 percent, 5 percent and 1 percent levels, respectively.

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Table 7 Liquidity Channel

Dependent Variable: Modification dummy					
	(1) Baseline	(2) Control for liquid assets/assets	(3) Control for liquidity assets/liabilities	(4) Test: *T*tptime(2)-T*tptime(1)=0*	(5) Test: *T*tptime(3)-T*tptime(1)=0*
T*tptime	1.483***	1.211***	1.229***	*chi-squared=20.88 Prob >chi-squared=4.80×10^{-6}*	*chi-squared=17.42 Prob >chi-squared=-0.0000299*
	(6.14)	(2.97)	(3.18)		
tptime	0.768***	0.939	0.926		
	(-3.57)	(-0.85)	(-1.05)		
T	1.781***	1.712***	1.705***		
	(2.89)	(2.69)	(2.66)		
Liquid assets/assets		3.512***			
		(10.84)			
Liquidity assets/liabilities			2.786***		
			(9.83)		
HAMP time	3.453***	3.141***	3.135***		
	(7.39)	(6.79)	(6.77)		
Interest rate	1.018	1.018	1.018		
	(1.51)	(1.49)	(1.48)		
Log original loan balance	1.733***	1.732***	1.732***		
	(21.40)	(21.43)	(21.42)		
LTV	0.992***	0.992***	0.992***		
	(-8.30)	(-8.32)	(-8.32)		
Debt-to-income ratio	1.012***	1.012***	1.012***		
	(22.32)	(22.29)	(22.30)		
Loan age	1.002**	1.002***	1.002***		
	(2.53)	(2.58)	(2.58)		
Multiple lien	0.838***	0.838***	0.838***		
	(-7.04)	(-7.05)	(-7.05)		
Fixed effects:					
Origination channel	Yes	Yes	Yes		
FICO buckets	Yes	Yes	Yes		
Mark-to-market LTV buckets	Yes	Yes	Yes		
MSA	Yes	Yes	Yes		
Servicer	Yes	Yes	Yes		
Origination year	Yes	Yes	Yes		
Delinquency quarter*year	Yes	Yes	Yes		

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Pseudo R-squared	0.142	0.142	0.142
Observations	680120	680120	680120

Notes: This table presents the results of robustness tests considering servicers' liquidity conditions. The dependent variable is an indicator that equals 1 if the delinquent loan is modified after the borrower defaults and 0 otherwise. *tptime* measures whether the borrower defaulted during the TARP period. *T*tptime* measures whether loans are exposed to TARP. The specific method used to construct *tptime* and *T*tptime* is introduced in Section 3.3. *T* takes the value of 1 if a loan comes from the treatment group and 0 otherwise. We control for loan characteristics and a series of fixed effects. Robust standard errors are clustered at the servicer level. Robust z-statistics are reported in parentheses. Odds ratios are reported to measure marginal effects. *, ** and *** indicate significance at the 10 percent, 5 percent and 1 percent levels, respectively. We conduct statistical tests to determine whether the estimates of *T*tptime* are significantly different from the baseline specification (Column (1)) when we include liquidity conditions in Columns (2) and (3) and display the results in Columns (4) and (5).

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Table 8 Foreclosure Horizon

Dependent Variable: Modification dummy	(1) within three months delinquency	(2) before six months delinquency	(3) Test: *T*tptime(2)-T*tptime(1)=0*
T*tptime	1.184	2.111***	*chi-squared=5.75 Prob >chi-squared=0.0165*
	(0.71)	(6.01)	
tptime	0.934	0.504***	
	(-0.27)	(-5.03)	
T	0.800	1.981***	
	(-0.55)	(2.65)	
HAMP time	0.482**	0.923	
	(-2.52)	(-0.38)	
Interest rate	0.941*	0.983	
	(-1.65)	(-1.07)	
Log original loan balance	1.390***	1.456***	
	(11.35)	(19.90)	
LTV	0.993***	0.993***	
	(-5.30)	(-7.72)	
Debt-to-income ratio	1.010***	1.011***	
	(12.23)	(23.03)	
Loan age	0.999	1.000	
	(-0.63)	(-0.48)	
Multiple lien	0.895***	0.888***	
	(-3.29)	(-4.22)	
Fixed effects:			
Origination channel	Yes	Yes	
FICO buckets	Yes	Yes	
Mark-to-market LTV buckets	Yes	Yes	
MSA	Yes	Yes	
Servicer	Yes	Yes	
Origination year	Yes	Yes	
Delinquency quarter*year	Yes	Yes	
Pseudo R-squared	0.128	0.127	
Observations	677134	679896	

Notes: This table presents the results of robustness tests, which are logistic regressions using different time horizons to measure modification. The dependent variable is an indicator that equals 1 if the delinquent loan is modified after the borrower defaults and 0 otherwise for Column (1)/Column (2). *tptime* measures whether the borrower defaulted during the TARP period. *T*tptime* measures whether loans are exposed to TARP. The specific method used to construct *tptime* and *T*tptime* is introduced in Section 3.3. *T* takes the value of 1 if a loan comes from the treatment

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group and 0 otherwise. We control for loan characteristics and a series of fixed effects. Robust standard errors are clustered at the servicer level. Robust z-statistics are reported in parentheses. Odds ratios are reported to measure marginal effects. *, ** and *** indicate significance at the 10 percent, 5 percent and 1 percent levels, respectively. We conduct a statistical test to determine whether the estimates of *T*tptime* are significantly different between Columns (1) and (2) and display the results in Columns (3).

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Table 9 Risk of Modified Loans

Risk of Modified Loans			
	(1)	(2)	(3)
Dependent Variable	FICO	Market-to-market LTV	Interest rate
T*tptime	-4.6595	-0.8375	-0.0362
	(-1.60)	(-1.42)	(-1.22)
tptime	6.9214**	0.7791	0.0435
	(2.24)	(1.39)	(1.42)
T	-23.1146**	0.2355	0.1466*
	(-1.98)	(0.10)	(1.77)
HAMP time	-37.6213***	48.2016***	-3.0622***
	(-5.65)	(11.21)	(-29.54)
Interest rate	-18.6044***	1.3377***	
	(-46.00)	(7.52)	
Log original loan balance	6.0648***	2.7706***	-0.2174***
	(10.04)	(7.10)	(-23.64)
LTV	0.4894***	1.0157***	0.0047***
	(14.41)	(52.52)	(12.28)
Debt-to-income ratio	0.0944***	0.0191***	0.0013***
	(3.85)	(7.30)	(9.75)
Loan age	0.4162***	-0.5865***	0.0093***
	(9.80)	(-13.61)	(7.46)
Multiple lien	18.6919***	-0.6500***	-0.0027
	-29.38	(-3.70)	(-0.79)
Fixed effects:			
Origination channel	Yes	Yes	Yes
FICO buckets	Yes	Yes	Yes
Mark-to-market LTV buckets	Yes	Yes	Yes
MSA	Yes	Yes	Yes
Servicer	Yes	Yes	Yes
Origination year	Yes	Yes	Yes
Delinquency quarter*year	Yes	Yes	Yes
Pseudo R-squared	0.14	0.794	0.401
Observations	162958	163753	163823

Notes: This table presents the least-squares regressions of loan characteristics on TARP and other variables. The sample only includes modified loans. The dependent variable is a loan attribute (FICO, mark-to-market LTV, or interest rate). *tptime* measures whether the borrower defaulted during the TARP period. *T*tptime* measures whether loans are exposed to TARP. The specific method used to construct *tptime* and *T*tptime* is introduced in Section 3.3. *T* takes the value of 1 if a loan comes from the treatment group and 0 otherwise. We control for loan characteristics and a series of fixed effects. Robust standard errors are clustered at the servicer level. Robust z-statistics are reported in parentheses. Odds ratios are reported to measure marginal effects. *, ** and *** indicate significance at the 10

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percent, 5 percent and 1 percent levels, respectively.

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Table 10 Intensive Margin

Dependent Variable: change in payment (%)	
	Intensive margin
Mean Dependent Variable	0.1113
T*tptime	-0.0163**
	(-2.03)
tptime	0.0119
	-1.38
T	-0.0148
	(-0.23)
HAMP time	0.7995
	-1.2
Interest rate	-0.0109**
	(-2.33)
Log original loan balance	0.0116***
	-2.61
LTV	-0.0004
	(-0.93)
Debt-to-income ratio	0.0003
	-1.63
Loan age	0.0011***
	-3.04
Multiple lien	-0.0089***
	(-5.50)
Fixed effects:	
Origination channel	Yes
FICO buckets	Yes
Mark-to-market LTV buckets	Yes
MSA	Yes
Servicer	Yes
Origination year	Yes
Delinquency quarter*year	Yes
R-squared	0.014
Observations	160267

Notes: The table presents a least-squares regression of monthly payment reduction on TARP and other information. The dependent variable is the reduction in the monthly payment. *tptime* measures whether the borrower defaulted during the TARP period. *T*tptime* measures whether loans are exposed to TARP. The specific method used to construct *tptime* and *T*tptime* is introduced in Section 3.3. *T* takes the value of 1 if a loan comes from the treatment group and 0 otherwise. We control for loan characteristics and a series of fixed effects. Robust standard errors are clustered at the servicer level. Robust z-statistics are reported in parentheses. Odds ratios are reported to measure marginal effects. *, ** and *** indicate significance at the 10 percent, 5 percent and 1 percent levels, respectively.

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