Private deposit insurance, deposit flows, and bank lending

Piotr Danisewicz
University of Bristol
School of Economics, Finance, and Management

Chun Hei Lee
University of Bristol
School of Economics, Finance, and Management

Klaus Schaeck
University of Bristol
School of Economics, Finance, and Management

May 2019

Do not quote or circulate. Preliminary version.

Abstract
We examine the role of private deposit insurance for deposit flows and bank lending during a financial crisis. Exploiting the availability of private deposit insurance to banks in Massachusetts, we show that banks whose deposits are privately insured experience greater deposit inflows and expand lending during the recent crisis, in contrast to banks whose deposits are only federally insured. The deposit inflows are particularly pronounced prior to the increase of the federal deposit insurance limit and the introduction of the Transaction Account Guarantee Program. Our results highlight the complementary role of private sector solutions for the regulatory framework in banking.

***Keywords**:* private deposit insurance, deposit flows, lending, financial crisis

JEL Codes: G21, G28

"No depositor has ever lost a penny in a bank insured by both the Federal Deposit Insurance Corporation and the Depositors Insurance Fund."
Statement on the web site of the Depositors Insurance Fund in Massachusetts

"At a member bank of the Depositors Insurance Fund, all your deposits and accrued interest are secure thanks to full deposit insurance."
Annual Report (2008), Depositors Insurance Fund in Massachusetts, p. 3

1. Introduction

This paper investigates whether banks whose deposits are not only insured by the Federal Deposit Insurance Corporation (FDIC) but are also fully insured by the Depositors Insurance Fund (DIF), a private deposit insurance scheme in Massachusetts, experience additional deposit inflows and increase their lending during the recent financial crisis.

The starting point of our analysis is the generally accepted notion that depositors seek a safe haven for their wealth during crises, and only when banks are awash with funds, they can provide liquidity during episodes of turmoil (Gatev and Strahan (2006)). The banking system was at the core of the financial crisis of 2007-2009, when the public held substantial concerns about the solvency of banks. Unsurprisingly, many investors sought a safe haven for their funds by switching from bank deposits to instruments with an explicit government guarantee that offers similar liquidity and payments services, such as Federal Home Loan Bank discount notes. Up to the point when the federal government extended their explicit support to banks in fall 2008,[1] the mechanism that allows banks to create liquidity by transforming deposits into loans collapsed (Acharya and Mora (2015)).

To examine whether the additional layer of protection provided by the DIF enables banks to act as an extra safe haven for depositors during a financial crisis, we exploit a unique setting in Massachusetts, where the DIF has provided private deposit insurance for state-chartered banks since 1934. Our setting is ideally suited to study the role of private deposit insurance. We can compare deposit flows and lending for the period 2004-2015 in banks that are members of the DIF with groups of banks that have only access to deposit insurance provided by the FDIC using quarterly branch-level and annual bank-level data for banks insured by the DIF.

[1] On 3rd October 2010, the federal government increased the deposit insurance coverage limit from 100,000 USD to 250,000 USD and provided full insurance of noninterest-bearing accounts.

Figure 1 illustrates deposit flows prior to, during, and after the recent financial crisis. The graph highlights that member banks of the DIF (represented by the dashed line) experienced deposit inflows during the crisis period (shaded area), while other banks located in Massachusetts (represented by the solid line) display deposit outflows until 2009. We therefore anticipate that the DIF member banks also increase their lending during the financial crisis (Ivashina and Scharfstein (2010)).

[FIGURE 1]

We obtain the following three novel results. First, deposits of DIF member banks increase relative to non-DIF banks during the financial crisis. This effect is statistically and economically significant, and cannot be explained by plausible alternative hypotheses such as DIF member banks deposits increase only comparing with banks that do not receive capital support under the Troubled Asset Relief Programme (TARP) or being perceived risker because they are subject to supervisory enforcement actions. To illustrate, when we constrain our sample to branches located in and banks headquartered in Massachusetts to prevent the influence of time-varying state-specific effects which we cannot control for because of the structure of our data, we find that deposits in branches operated by DIF member banks increase by 18.1% annually.[2]

A series of further tests reinforces the beneficial effect of DIF membership on deposit flows. We find that the magnitude of the increase in branch-level deposits is greater prior to the increase in federal deposit insurance from 100,000 USD to 250,000 USD and prior to the introduction of the Transaction Account Guarantee Programme (TAGP), which provided unlimited deposit insurance for noninterest-bearing transaction accounts.

Second, the use of bank-level data permits confirms the branch-level results, and permits additional tests for different types of deposits. We find that the effect of DIS membership is only significant for interest-bearing deposits. However, the key coefficient remains insignificant for noninterest-bearing deposits which are fully insured by the Transaction Account Guarantee

[2] See Table 4, Panel B, Column 3. The effect is calculated as *exp*(0.166) =18.1 percent.

Programme. Taken together, our tests highlight the beneficial effect of private deposit insurance on deposit flows, irrespective of the level of aggregation. They also suggest that depositors are well aware of the differential effects of private deposit insurance.

Third, DIF member banks significantly increase lending during the financial crisis. The increase in lending is primarily driven by residential mortgage lending, and loans with longer maturities. This result indicates that the unlimited insurance coverage of private deposit insurance might provide banks with a more stable deposit funding during the crisis, which eventually leads to more long-term lending. Our initial set of tests for lending are performed on the bank-level. Consequently, they do not comprehensively allow disentangling demand and supply. We therefore use in a fourth set of tests data from the Home Mortgage Disclosure Act (HMDA) to better control for local economic conditions and demographic information of mortgage applicants. In these tests, we document that DIF member banks are more likely to accept mortgage applications during the crisis. These latter two results are consistent with the argument by Ivashina and Scharfstein (2010) that banks with better access to deposit financing reduce their lending less during the financial crisis.

These findings are important for two reasons. First, and unlike prior work on deposit insurance, we provide evidence on the role of private deposit insurance during a crisis. Although prior studies discuss potential benefits of private deposit insurance (e.g., England (1985), Calomiris (1989), Calomiris (1990), Beck (2002)), no empirical evidence has been provided to support their claims. Our work presents *prima facie* evidence that a well-operated private deposit insurance complements government-supported deposit insurance. The findings in our research reject the view that the credibility of a deposit insurance scheme is exclusively dependent on government support. Although we qualify our findings that they may not necessarily be transposed to other countries with different institutional features, we provide valuable insights into the design features of a deposit insurance scheme that assigns a key role to private parties.

Second, and beyond the insights from a public policy perspective, our results highlight a key role of deposits during financial crises and their role for bank lending. We document that membership

in a private deposit insurance fund allows banks better access to deposits during crises, which, in turn, enables its members to sustain lending. These findings suggest that banks which are better able to raise deposits are less vulnerable to short-term funding problems. Our results therefore also inform the debate about how to mitigate the adverse effects of deposit volatility for bank lending and support more broadly also the establishment of the net stable funding ratio requirement under Basel III.

The remainder of this paper is organized as follows. Section 2 describes the institutional background of the DIF and Section 3 develops our hypotheses. Section 4 describes the data and methodology. In Section 5 we present the main results and Section 6 reports on extensions. We offer some concluding remarks in Section 7.

2. Institutional background

We provide in Section 2.1 an overview of the key characteristics of the DIF, followed by a comparison of the DIF with FDIC deposit insurance in Section 2.2. Section 2.3 offers a synopsis of the history of deposit insurance in the U.S.

2.1. Characteristics of the DIF

The DIF is a private, industry-sponsored insurance company that was established by the Massachusetts legislature in 1934 as a response to the Great Depression. The DIF provides deposit insurance to state-charted savings banks whose headquarters are located in Massachusetts.[3] Initially, membership of the FDIC and DIF was mutually exclusive. This rule changed in 1956, since then, the DIF insures deposits over the FDIC insurance coverage limit.

We next describe the characteristics of the DIF in 5 key aspects: (i) insurance coverage; (ii) membership; (iii) funding; (iv) management; and (v) public awareness.

(i) Insurance coverage

The DIF offers full deposit insurance for its members' deposits and accrued interest without

[3] Total assets of the DIF in 2008 amount to 355 million USD. Most of the DIF assets are U.S. Treasury and federal agency obligations, and obligations fully guaranteed by the U.S. government. In Massachusetts, there is another private deposit insurance provider, the Share Insurance Fund. The Share Insurance Fund is exclusively available to cooperative banks which are not relevant to our study because our sample only includes commercial and savings banks.

limit. All deposits above the FDIC insurance coverage limit in DIF member banks are insured by the DIF. The DIF insures all types of deposit accounts, including savings accounts, checking, and NOW accounts, certificates of deposit (CDs), money market deposit accounts, and retirement deposit accounts. Whether or not DIF insurance applies only depends on the membership of banks in the DIF, but not on the location of branches or residence of depositors.[4]

(ii) Membership

Membership in the DIF is voluntary, but only state-chartered savings banks from Massachusetts can join the DIF. The number of members varies over time due to mergers and acquisitions, changes in charters, and bank failures. During our sample period 2004-2015, 49 banks are consistently members of the DIF.[5]

(iii) Funding

The DIF is exclusively funded by its members, without any support of either the federal or the state government. Its sources of funds include accumulated annual assessments on its members and interest income from its investments.

The board of directors of the DIF determines the assessments rates based on excess deposits and risk classifications of each DIF member bank. However, the assessment rate must be approved by the Commissioner of Banks of the Commonwealth of Massachusetts.

Massachusetts law and the DIF's investment policy restrict the investments of the DIF. The majority of the DIF investments are U.S. Treasury and federal agency obligations, and obligations fully guaranteed by the U.S. government.

(iv) Management

The DIF is privately managed without any government participation. The board of directors primarily consist of presidents and chief executive officers of DIF member banks. Although the DIF is

[4] Foreign deposits are not insured by the DIF, but foreign deposits play a limited role for DIF member banks. Most of the DIF member banks have zero value of foreign deposits.

[5] The number of members in 2004-2015 is available from the DIF annual report.

privately run, it is examined annually by the Massachusetts Division of Banks and audited by an independent auditor.

The DIF supervises its members by quarterly reviewing their financial reports. The DIF also meets regularly with the FDIC and the Massachusetts Division of Banks following examinations of its members by these two agencies. Based on the condition of the individual banks, the DIF may adjust the assessment rate of respective banks.

(v) Public awareness

Members display the DIF logo on their website, on doors and at teller stations, depositors can access the details of the DIF through its website, marketing brochures, and customer service representatives.

During the crisis, there was an increasing media attention that focused on the unlimited deposit insurance coverage provided by the DIF. For example, an article "Massachusetts sets standard on deposits" published by the Wall Street Journal on 5th August 2008 reported on the unlimited insurance coverage of DIF member banks.[6] Moreover, the article also highlights that DIF member banks had reported many inquiries from new and existing clients prior to publication of the article.

"[…] turmoil in the banking industry has been a boon for state-chartered banks and some credit unions in Massachusetts. In recent weeks, they've been inundated with inquiries from new and existing clients."

This article provides evidence for the public awareness of the DIF during the crisis. Moreover, it also illustrates that unlimited coverage of DIF member banks attracted depositors during the crisis.

The annual report of the DIF in 2008 also reported increased enquiries from depositors during the financial crisis.[7]

"[…] the DIF received numerous telephone calls, emails, and letters from depositors as well as local and national media inquiring about DIF insurance, and I know that many of our members received increased inquiries as well."

---

[6] The article of the Wall Street Journal is available on https://www.wsj.com/articles/SB121789647048112087.

[7] The DIF 2008 annual report is available on https://www.difxs.com/reports/AnnualReports/DIFAnnualReport2008.pdf.

Google Trends provides additional evidence that suggests increasing interest in the DIF during the crisis.[8] Figure 2 shows the monthly Google Trends index in 2004-2015, indicating the search volume of "Depositors Insurance Fund" in Massachusetts. Prior to the crisis, the index constantly stayed at zero, indicating that the general public was not interested in the DIF. However, the search volume index increased since the onset of crisis, reaching its peak in the month of the bankruptcy of Lehman Brothers, September 2008. This illustration supports the view that depositors' interest in the DIF was increasing amid greater concern about financial system soundness during the crisis.

[FIGURE 2]

2.2. Comparison between the DIF and the FDIC

All U.S. banks are insured by the FDIC, only the excess deposits of DIF member banks are insured by the DIF. We now compare the DIF with the FDIC in Panel A of Table 1.

[TABLE 1]

An obvious difference is the insurance coverage limit. The DIF offers unlimited insurance coverage, while the deposit insurance coverage of the FDIC is 250,000 USD. Prior to Q3:2008, the coverage limit of the FDIC was 100,000 USD. Membership of the DIF is voluntary, but it is compulsory for the FDIC. Other obvious differences concern the management style. While the FDIC is a federal agency, the DIF is privately funded and managed.

2.3. Synopsis of deposit insurance in the U.S.

Deposit insurance in the U.S. has experienced turbulent times. Many deposit insurance funds failed, including both state-sponsored and private deposit insurance funds. Several private insurance funds disappeared gradually, reflecting the imposition of a 10% federal tax on state-chartered bank notes in 1900 (Calomiris (1990)), and the establishment of the FDIC in 1933 (English (1993)).

Following the definition of success and failure in Calomiris (1989), we define a successful deposit insurance fund as one that completely protects the payment system without motivating risk-

[8] Google Trends is a website by Google that records the popularity of search queries in Google Search across various regions and languages.

taking of banks, while failure is defined as a situation where a deposit insurance fund fails to protect the payment system or collapses due to design flaws. In Appendix A, we summarize 5 common characteristics of successful and failed deposit insurance funds based on White (1981); Calmoris (1989); Calmoris (1990); English (1993). The objective of our brief survey is to evaluate the credibility of the DIF in this section before we develop our hypotheses.

Despite concerns about adverse selection depicted in Appendix A, the DIF is properly designed with an incentive compatible mechanism, and sufficient reserves against significant losses. These factors are likely to have played a major role for the survival of the DIF during numerous crises between 1934-2018.[9]

3. Hypotheses Development

We first develop predictions for deposit flows of DIF member banks during the financial crisis. Next, we discuss lending of DIF member banks, assuming deposits increase for DIF member banks during the financial crisis.

3.1. Deposits of DIF member banks during the crisis

Gatev and Strahan (2006) suggest that government support differentiates banks from other financial intermediaries during financial crises. In line with this argument, Pennacchi (2006) highlights that banks failed to offer such protection to depositors prior to the introduction of federal deposit insurance. Government responses also play a crucial role on deposit flows in recent financial crisis (Figure 4), Acharya and Mora (2015) find that banks do not experience additional deposit inflows in the initial stage of the recent financial crisis until they receive explicit support from the government, including the increase of the FDIC deposit insurance limit from 100,000 USD to 250,000 USD per depositor and introduction of the Transaction Account Guarantee Programme (TAGP).

Moreover, deposit insurance does not only encourage deposit inflows to banks, but also deters deposit outflows from banks during financial crises as argued by Diamond and Dybvig (1983);

[9] No DIF bank failed during the recent financial crisis.

Demirgüç-Kunt et al. (2015); and Martin et al. (2018). Taken together, these studies highlight that investors allocate their wealth to banks during crises because of government-supported deposit guarantees.

[FIGURE 4]

In contrast to these studies, we ask whether the DIF can serve as a complement to government guarantees during a financial crisis. In other words, we hypothesize that depositors reallocate their funds to banks that offer additional protection via their membership in the DIF during a crisis. Our preliminary inspection of the data in Figure 1 provides visual evidence supporting this view.

We formulate Hypothesis 1 in the null form as follows:

Hypothesis 1: Following the onset of the financial crisis, there is no effect of DIF membership on deposits.

3.2. Lending of DIF member banks during the crisis

Providing credit and liquidity to the economy is one of the key roles of banks. Bernanke (1983) illustrates the adverse effects of credit contraction during the Great Depression. Therefore, governments encourage lending and liquidity creation, to avoid contractions during financial crises. For instance, the 'Emergency Economic Stabilization Act (EESA) of 2008 in the U.S. is designed to encourage liquidity creation of banks. Since lending plays an important role, we therefore explore whether lending by DIF member banks increases during the crisis. As part of this analysis, we examine which types of loans increase for DIF member banks.

Ivashina and Scharfstein (2010) show that banks generally reduce lending during the crisis due to funding constraints. However, banks with better access to deposit financing reduce their lending less. Assuming that the access to private deposit insurance isolates banks from the liquidity constraints they may otherwise face as reflected in Hypothesis 1, DIF member banks are likely to increase lending during the crisis. As privately insured banks expect fewer withdrawals during crises, they have greater incentives to transform liquid deposits into illiquid loans, such as loans with longer maturity.

We formulate Hypothesis 2 as follows:

Hypothesis 2: Following the onset of the financial crisis, there is no effect on bank lending for DIF member banks.

On the other hand, lending of the member banks may remain unaffected or decrease during the financial crisis, because private deposit insurance discourages risk taking (Beck (2002)). As shown in Section 2, several characteristics of the DIF encourage peer monitoring, such as the mutual liabilities and unlimited assessment rate. While these design features maintain sustainability of the DIF, they also discourage lending of its members during crises. Exiting the DIF sends a negative signal to the market, especially during crises. Therefore, DIF member banks may avoid expulsion through minimizing portfolio risk. During crises, banks minimize risk by preserving liquidity (Bernanke (1983); Acharya and Skeie (2011)), and banks use the additional deposits to build up liquid assets, instead of loans, either by decreasing lending or leaving it unchanged.

4. Data and Methodology

We obtain annual data for the period 2004-2015 for branches of commercial and saving banks in the U.S. from the Summary of Deposit, available from the FDIC. We complement the Summary of Deposit with quarterly data for commercial and savings banks from the Call Reports during the period Q1:2004- Q4:2015, available from the Federal Reserve Bank of Chicago. We choose this time span because information on DIF membership is available from 2004 annually. Our sample period includes the recent financial crisis period (Q3:2007-Q4:2009), as defined by Berger and Bouwman (2013).

[FIGURE 3]

To minimize geographic heterogeneity, our sample includes branches in Massachusetts and the 5 states surrounding Massachusetts, including Connecticut, New Hampshire, New York, Rhode Island and Vermont (Figure 3). We exclude banks if they have: (i) zero deposits; (ii) zero lending; (iii) balance sheet items with negative values; or (iv) missing data for the control variables, as described below.

Following Gatev et al. (2007), we use the most recent merger file from the Federal Reserve

Bank of Chicago to identify mergers and acquisitions and drop observations that are involved in M&As during the year of the M&As. We only include branches of banks that operate in at least one year prior to and following the onset of the crisis. This results in a sample of 69,108 observations for 7,006 branches operated by 365 banks in all 6 states. To eliminate state-specific effects, most of our tests are based on branches in Massachusetts and banks headquartered in Massachusetts during the period 2004 to 2015. On the branch level, this results in a cleaner sample of 13,189 observations for 1,361 branches. On the bank level, this results in a sample of 3,449 observations for 83 banks.

[TABLE 2]

Panel A of Table 2 presents descriptive statistics, and summarizes branch level deposits on an annual basis for all branches in Massachusetts and all other variables for banks headquartered in Massachusetts, which are on the institution-level and on a quarterly basis. Panel B of Table 2 compares different variables of DIF member banks with other saving banks in the U.S., suggesting that DIF member banks are similar to other savings banks, apart from the fact that DIF member banks have lower average deposit and loan interest rates. The lower average interest rate on deposits possibly reflects the benefit of unlimited deposit insurance coverage. With the lower cost of deposits, DIF member banks could also provide a more competitive loan rate.

4.2. Methodology

To examine whether DIF member banks obtain the additional deposits during the recent crisis, we estimate the following model on the branch level:

$$Deposit_{v,i,t} = \beta_0 + \beta_1 Membership_i \times Crisis_t + \delta X_{i,t} + \gamma_v + \gamma_t + \epsilon_{v,i,t} \quad (1)$$

where $Deposit_{v,i,t}$ is the logarithm of deposits for branch *v* operated by bank *i* at time *t*, capturing deposits of each branch; $Membership_i$ indicates whether a bank is member of the DIF, it equals one if a bank is a member of the DIF (0 otherwise). Since we define members of the DIF as banks that are

consistently members of the DIF during the period 2004-2015, $Membership_i$ is a time-invariant variable. $Crisis_t$ takes on the value of 1 if the observation is in the crisis period (0 otherwise). $Membership_i \times Crisis_t$ equals 1 for the observations of branches operated by DIF member banks during the crisis period (0 otherwise). We define crisis period as Q3:2007-Q4:2009 according to Berger and Bouwman (2013). β_1 is our coefficient of interest and informs Hypothesis 1.

$X_{i,t}$ is a vector of time-varying control variables which includes the logarithm of total assets, the ratio of total deposit interest expenses to total deposits, the charge off ratio, and the Tier 1 capital ratio. γ_v is a branch-fixed effect which captures branch-specific factors, and γ_t is a year-fixed effect. This battery of dummy variables allows us to rule out all unobservable and time-varying forces that might drive changes in deposit flows and coincide with the crisis period. We cluster heteroskedasticity-adjusted standard errors on the branch level to account for serial correlation within each panel.

On the institutional level, we estimate

$$Y_{i,t} = \beta_0 + \beta_1 Membership_i \times Crisis_t + \delta X_{i,t} + \gamma_i + \gamma_t + \epsilon_{i,t} \quad (2)$$

where $Y_{i,t}$ is a dependent variable for bank *i* at time *t*, capturing either institutional level deposits or loans. A positive coefficient β_1 informs Hypothesis 1and Hypothesis 2. The institution-level data is on a quarterly basis. γ_i controls for bank-fixed effects, and γ_t controls for quarter-fixed effects. The definition of other variables follows the branch level model, except that time *t* is on quarterly basis. We

cluster heteroskedasticity-adjusted standard errors on the bank level in Equation 2.[9]

In the model for deposit flows, we control for the logarithm of total assets to measure bank size. To account for pricing effects, we use the ratio of total deposit interest expenses to total deposits as the measure of average interest rates on deposits. Furthermore, we use the charge off ratio to measure bank risks, and the Tier 1 capital ratio to measure capitalization. We obtain all control variables from the Call Reports. In our analysis on the branch-level, we collapse quarterly data into annual data. We use the same control variables in testing Hypothesis 2, except for the interest expenses ratio, where we replace it with the ratio of total interest income on total loans to total loans. All control variables are lagged by3 years to mitigate concerns about endogeneity.[10]

4.3. Selection into membership and sample choice

Our variable of interest, $Membership_i \times Crisis_t$ is plausibly exogenous for two reasons.

First, a driving force behind the recent crisis was a credit boom which fuelled a housing bubble. Conceivably, the lending behavior of DIF member banks could contribute to the build-up of the crisis. However, Acharya and Richardson (2009) suggest that the recent crisis is largely driven by a shift of banks' business models towards securitization adopted by large, complex financial institutions. DIF member banks are local saving banks, and none of them has assets over 50 billion USD during our sample period, Thus, these banks at best played a very limited role in triggering the recent financial crisis. Therefore, $Crisis_t$ is plausibly exogenous to their deposits and lending. Likewise, the "too big to fail" explanation could also hardly be invoked to explain the deposit inflows to the DIF member banks during the crisis.

Second, we mitigate selection problems by defining members of the DIF as banks that are consistently members of the DIF during the period 2004-2015. Banks acquire membership well before

[9] Iyer, Puri and Ryan (2016) provide evidence for the heterogeneity in depositor responses to solvency risk; Iyer and Puri (2012) show that relationships with depositors and depositors social networks mitigate bank runs. One of the limitations of this paper is the fact that we do not have depositor-level data to control for the role of depositors' characteristics in our study.

[10] Since the crisis period is across three years, a shorter lag possibly causes correlation between the variable of interest with the control variables. In other words, we would plausibly suffer from a "bad control" problem with a shorter lag, as described by Angrist and Pischke (2008).

the unexpected financial crisis in Q3:2007-Q4:2009. Banks that join the DIF during the financial crisis are excluded. Therefore, the membership of banks during the crisis is not conditional on banks' deposits and lending in our analysis. To further mitigate concerns that selecting into DIF membership prior to the year 2004 reflects bank soundness during the financial crisis, we exclude all savings banks in Massachusetts that are not DIF member in our main results.[11] Since the DIF membership is only available for saving banks headquartered in Massachusetts, we ensure that DIF membership is not even a valid choice for non-DIF banks in our sample.[12]

4.4. Do non-DIF banks constitute a valid counterfactual?

The validity of our estimation requires non-DIF banks to constitute a valid counterfactual for the DIF banks. If this is the case, our dependent variables of the DIF banks would have evolved in a similar fashion to non-DIF banks during the pre-crisis period. This section shows that non-DIF banks are a valid counterfactual for DIF member banks.

[TABLE 3]

Most of our tests are based on branches in Massachusetts and banks headquartered in Massachusetts. We therefore compare the growth rate of various dependent variables of DIF member banks to non-DIF banks during the pre-crisis period. Table 3 examines whether there are significant differences in the annual growth rate of branch level deposits and in the quarterly growth rate of other variables between the DIF banks and non-DIF banks during the pre-crisis period. The null of the equality of means cannot be rejected in any but 2 out of 44 cells, suggesting non-DIF banks plausibly constitute a valid counterfactual for DIF member banks.

5. Empirical Results: Private deposit insurance and deposit flows

In this section, we examine the effect of the DIF on deposit flows during the recent financial

[11] During our sample period, there are 8 saving banks headquartered in Massachusetts that are neither DIF members nor DIF members consistently DIF members. By excluding these 8 banks, our sample has 51 DIF member banks.

[12] In Appendix B, we show that our result is robust to the inclusion of Massachusetts savings banks that are not DIF members and switch into DIF membership during the sample period. The deposit inflows of DIF member banks are even more pronounced, compared with this group of excluded banks. We choose not to include them in our main result to avoid concerns over membership selection.

crisis. Further tests aim to disentangle the effect of the DIF on deposit flows from other alternative explanations.

5.1. Effect of the DIF on deposits on the branch level

Table 4 examines the effect of the DIF on deposits during the crisis. The estimates for our coefficient of interest, β_1, are significant and display the expected positive sign.

To reflect on the fact that data from the Summary of Deposits are only available on an annual basis, Panel A of Table 4 defines the crisis period as Q3:2007-Q2:2010, which includes the crisis period, Q3:2007-Q4:2009, defined by Berger and Bouwman (2013).

Column 1 and Column 2 in Panel A show the results for the full sample, including all branches operating in Connecticut, Massachusetts, New Hampshire, New York, Rhode Island and Vermont. Column 1 only includes the variable identifying DIF member banks during the crisis without any control variables. There is a significant increase in deposits of 1.8% (*t*-statistic of 2.01) for the member banks of the DIF during the crisis, rejecting Hypothesis 1. Column 2 includes control variables. If our key variable of interest is exogenous, both its magnitude and significance will not be affected by the inclusion of control variables (Roberts and Whited (2013)). Therefore, Column 2 provides additional evidence for the exogeneity of the variable of interest with respect to deposit flows. The coefficient and the *t*-statistic on the variable is virtually identical to Column 1.

Columns 3 to 5 show the results for restricted samples. We expect the increase in deposits of the DIF to be more pronounced when we only consider branches in Massachusetts because depositors incur lower cost to transfer deposits within Massachusetts, in terms of transportation cost, monitoring cost, and information cost.

Column 3 shows the results for the sample including all branches in Massachusetts, regardless of their headquarters' location. Deposits of member banks increase by 9.6% (*t*-statistic of 8.56) during the crisis. Compared with the results in Column 1 and 2, the magnitude of the increase in deposits is greater, confirming our expectation.

Column 4 only includes Massachusetts branches of banks headquartered in Massachusetts, while the control group in Column 5 only includes Massachusetts branches operated by non-DIF banks headquartered outside Massachusetts. Since depositors incur lower information cost and monitoring cost for banks headquartered in their state of residence, we expect that the coefficient of interest to be lower when we only include Massachusetts branches operated by Massachusetts banks in the sample. In other words, we expect depositors to transfer deposits from non-DIF banks to member banks, especially from non-Massachusetts banks to DIF member banks. The result in Column 4 indicates an increase in deposits for DIF member banks during the crisis, the size and significance level of the estimated β_1 is lower compared with Column 5. In Column 5, we only include Massachusetts branches operated by non-Massachusetts banks as control group, deposits of the member banks increase by 8.7% (*t*-statistic of 7.41) during the crisis.

[TABLE 4]

Panel B of Table 4 adopts a narrower definition of the crisis period, classifying the crisis to occur from Q3:2007 to Q2:2008. We expect deposit growth of DIF member banks to be greater prior to the increase of the FDIC deposit insurance coverage limit from 100,000 USD to 250,000 USD per depositor on 3rd October 2008 and the introduction of the Transaction Account Guarantee Program on 14th October, 2008. Therefore, we expect the estimates for our coefficient of interest, β_1, to be larger in Panel B. If it is the case, it not only shows robustness of our result in terms of the definition of the crisis period, but rather, it reinforces the idea that unlimited insurance coverage of DIF member banks explains the deposit inflows.

The results in all columns of Panel B support this view. The estimates for β_1 substantially increase in magnitude across the different samples. In addition, the significance level of the coefficient in Panel B of Column 4 (*t*-statistic of 3.38) is also higher than the one in Panel A of Column 4.

In sum, there is strong evidence that DIF membership is associated with deposit inflows during the crisis. Our results are robust to the definition of crisis period, and the deposit inflows are greater prior to the expansion of the government guarantees.

5.2. Ruling out alternative explanations

Our following discussion focuses on the sample with all branches in Massachusetts. Considering the fact that transportation cost and information asymmetries arising from the distance between banks and their borrowers rise in distance (Degryse and Ongena (2005)), we expect transportation cost and information cost of transferring deposits within branches in the same state to be lower. Therefore, we argue that the transfer of deposits is more likely to occur between DIF member banks and non-DIF banks in Massachusetts.

DIF member banks experience deposit growth during the crisis. It is possible, however, that the deposit inflows are caused by a pricing channel or simply reflect a 'flight to safety'. Both these explanations could generate the empirical patterns we observe in the data, and we could misattribute our results to the unlimited insurance coverage offered by the DIF.

To rule out these alternative explanations, we split the control group according to the pre-crisis average value of the following variables: (i) proportion of uninsured deposits to total deposits; (ii) interest expense ratio; (iii) Tier 1 capital ratio; (iv) charge off ratio; and (v) the Z-score.[13] We follow Paternoster et al. (1998) to test the equality of the coefficient of interest across different samples and report *p*-values from this test at the bottom of each panel A of Table 5.

Flight of uninsured deposits

In Table 5, Column 1 includes branches in Massachusetts operated by non-DIF banks where the proportion of uninsured deposits lies above the median of non-DIF banks as the control group. Column 2 includes branches in Massachusetts of non-DIF banks where the proportion of uninsured

[13] The Z-score is an accounting-based measure of distance to default, calculated as the sum of return on assets (ROA) and the equity-to-asset ratio divided by the standard deviation of ROA, calculated over a three-year rolling time window. As the Z-score is not normally distributed, we use a log transformation of Z-score, which is defined as Z-score (ln). Z-score (ln) is negatively related to the probability of default.

deposits is below or equal to the median as the control group. Assuming depositors transfer their funds to DIF member banks to obtain unlimited insurance coverage provided by the DIF, non-DIF banks with higher levels of uninsured deposits, regardless of their soundness, should experience greater deposit outflows, and *vice versa* for the non-member banks with lower uninsured deposits.

The results in Column 1 and 2 support this view. The coefficient for β_1 in Panel A and Panel B in Column 1 almost doubles, compared with the result in Column 2. The equality of the coefficient of interest between the two samples is also rejected. These findings suggest that depositors transfer deposits to DIF member banks because of their unlimited insurance coverage.

Pricing channel

With the extra protection of unlimited deposit insurance, it is unlikely that DIF member banks feel the need to offer higher interest rate for deposits during the crisis.[14] To further address this concern over the pricing channel in driving our results, we separate the control group according to their average interest expense ratio.

We present the result in Column 3 and 4 of Table 5. The results do not support the conjecture that deposit inflows of DIF member banks are driven by higher deposit interest rates. On the contrary, the increase in deposits of DIF member banks are even more pronounced, compared with non-DIF banks paying higher interest rate on deposits.

Flight to safety

Next, we present tests that try to rule out that bank soundness plays a role for deposit flows. Although it seems plausible to expect that bank soundness affects the magnitude of deposit flows, the positive effect of DIF membership on deposits inflows should be robust to the splitting the control group.

The results in Panel A and Panel B in Columns 5 to 10 of Table 5 support our expectation. Using

[14] During the crisis, the Federal Reserve has lowered the target federal funds rate to slightly over zero to address problems in financial markets and the real economy.

various measures of bank soundness, we find no evidence that the deposit inflows of the DIF member are driven by "flight to safety". Even when we compare the treatment group with non-DIF banks with higher Tier 1 capital ratios, lower charge off ratios, and higher Z-scores, deposits of DIF member banks still significantly increase during the crisis. Moreover, all equality tests suggest that all pairs of the coefficients of interest in Panel A and Panel B in Columns 5 to 10 are statistically different from each other.

[TABLE 5]

In sum, our results are robust to splitting the control group alongside several different dimensions. The effect of DIF membership on deposit inflows during the crisis is stronger when the control group only consists of banks with greater exposure to uninsured deposits prior to the crisis. These results also support the view that depositors transfer their uninsured deposits from non-DIF banks to DIF members. On the other hand, the results reject that the deposit inflows are purely driven by the pricing channel and soundness of banks.

5.3. Are DIF members safer banks during the crisis?

To further address the "flight to safety" concern, we test whether DIF member banks are safer than non-member banks during the crisis. If this is the case, depositors may transfer deposits to DIF members as a result of the "flight to safety", which may not be related to the private insurance provided by the DIF. To test this assumption, we estimate Equation 3 using logit regressions:

$$Member_{2007,i} = \beta_0 + \beta_1 Enforcement\ actions_i + \beta_2 Severe\ enforcement\ actions_i + \beta_3 Charge\ off\ ratio_i + \beta_4 Z - score(ln)_i + \epsilon_i \quad (3)$$

where $Member_{2007,i} = 1$ (0 otherwise). We proxy bank soundness in terms of whether banks are subject to enforcement actions or severe enforcement action during the crisis. $Severe\ enforcement\ actions_i = 1$ for banks that are subject to (severe) enforcement actions during the

crisis. As a further measure, we use the charge-off ratio and the logarithm of Z-score during the crisis, denoted by the $Charge\ off\ ratio_i$; and $Z\text{-}score(ln)_i$ respectively.[15]

[TABLE 6]

We estimate Equation 3 based on the sample that includes all banks headquartered in Massachusetts and all banks operating branches in Massachusetts. Since we exclude banks that switch their membership status during the sample period, our estimations of Equation 3 are identical whether DIF membership is measured at other pre-crisis years or not.

Column 1 and 2 of Table 6 show that our different proxies of bank soundness are not related to DIF membership status, irrespective of whether we focus on Massachusetts-headquartered banks or other banks operating branches in Massachusetts, respectively. Overall, these tests highlight that the flight to safety cannot explain the deposit flows of DIF member banks during the crisis.

5.4. The Troubled Asset Relief Program and enforcement actions

We now investigate the influence of the TARP and enforcement actions on our previous inferences. To this end, we divide non-DIF banks into 6 categories in Table 7: (i) participants of the TARP, (ii) non-participants of the TARP, (iii) banks subject to enforcement actions during the crisis period, (iv) banks not subject to enforcement actions during the crisis period, (v) banks subject to severe enforcement actions during the crisis period, and (vi) banks subject to less severe enforcement actions during the crisis period.[17] [16]No DIF-insured banks participate in the TARP, but two of the DIF-insured banks are subject to enforcement actions during the crisis.

Influence of the TARP

During the financial crisis, the U.S. treasury infused capital into many banking organizations

[15] We omit the Tier 1 capital ratio as one of the measures of bank soundness in the auxiliary equation, because the Z-score already captures the information contained in the Tier 1 capital ratio.

[16] The web site of the U.S. Department of the Treasury contains details the participants of TARP (https://www.treasury.gov/initiatives/financial-stability/TARP-Programs/Pages/default.aspx), and data on enforcement actions during the pre-crisis period is available from the SNL financial, a database provided by S&P Global Market Intelligence.

through the Capital Purchase Programme (CPP) of the TARP, aiming to restore financial stability and facilitate credit availability.[17]Berger and Roman (2015) point out that the recipients of the CPP gain competitive advantages, thus increasing their market shares and market power. They further suggest that the result is explained by the safety channel, suggesting that recipients of the CPP are considered to be safer in comparison to non-recipients of the CPP. Bayazitova and Shivdasani (2012) find that recipients of the CPP experience excess stock returns on the announcement date of CPP capital infusions. Based on these findings, receipt of capital through the TARP signals positive information on bank safety. Therefore, it is possible that TARP also triggers deposit inflows to its recipients.

[TABLE 7]

Since the TARP starts in Q3:2008 and the crisis period is defined as Q3:2007 to Q2:2008 in Panel B, the estimate for β_1 in Columns 1 and 2 of Panel B should be similar. Our results in Column 1and 2 of Panel B indicate DIF member banks experience similar magnitudes of deposit inflows. In Panel A, Column 1 indicates that deposits of DIF member banks increase by 7% (*t*-statistics 4.84), compared with recipients of the TARP. Column 4 indicates deposits of DIF members increase by 4.3% (*t*-statistics 3.67), compared with non-recipients of the TARP. All equality tests suggest that participation in the TARP plays no role for the increase of deposits of its recipients during the crisis.

Influence of enforcement actions

Supervisory actions possibly also affect deposit flows. Enforcement actions identify banks that are subject to supervisory attention and require immediate remedial action to avoid further sanctions. Since enforcement actions convey unfavourable information on soundness to the public (Jordan et al. (2000); Delis at al. (2016); Danisewicz et al. (2018)) we expect i) the estimate for β_1 to be higher (lower) when the control group only contains banks subject to enforcement actions (not

[17] Under the Capital Purchase Programme (CPP), the U.S. treasury infused capital into recipient banks in the form of preferred stock.

subject to enforcement actions), and ii) the estimated β_1 increases in the severity of enforcement actions experienced by the control group.[18] Among the 52 non-DIF banks in our sample, 19 are subject to enforcement actions of which 11 of these non-DIF banks are subject to severe enforcement actions, while 8 of them are subject to less severe enforcement actions.

Table 7 shows the results of splitting the control groups by enforcement actions during the crisis. The control group in Column 3 includes branches in Massachusetts operated by non-DIF banks subject to enforcement actions during the crisis, while the control group in Column 4 includes branches in Massachusetts operated by non-DIF banks that are not subject to enforcement actions.

We find in Panel A of Column 3, that deposits of branches operated by DIF-insured banks increase by 11.4% (*t*-statistic 9.24) during the crisis, compared with non-DIF banks that are subject to enforcement actions. The estimated β_1 decreases in Column 4, which only includes non-DIF banks that are not subject to enforcement actions as a control group. Deposits of branches operated by the DIF-insured banks only increase by 4% (*t*-statistic 2.25), shown in Panel A of Column 4. The results in Panel B show that enforcement actions have stronger positive effect on β_1 in the period prior to the increase of the FDIC deposit insurance coverage limit and prior to introduction of the TAGP.

Our control group in Column 5 includes branches in Massachusetts operated by non-DIF banks that are subject to severe enforcement actions. Panel A of Column 3 shows that deposits in branches operated by the DIF-insured banks increase by 14.0% (*t*-statistic 8.43). When the control group only includes branches in Massachusetts operated by non-DIF banks that are subject to less severe enforcement actions, deposits of branches operated by the DIF-insured banks increase by 10.0% (*t*-statistic 6.76), shown in Panel A of Column 4. The estimate for β_1 is larger when our control

[18] We define formal written agreements, cease and desist orders, prompt corrective action directive, and/or deposit insurance threats as severe actions, while less severe actions include enforcement actions against personnel and individuals, formal memoranda of understanding, hearing notices, sanctions due to HMDA violation and/or other actions.

group only includes banks subject to severe enforcement actions. Consistent with the results in Column 3 and 4, the difference in the estimates for β_1 is more obvious at the initial stage of the crisis, shown in Panel B of Column 5 and 6.

To conclude, the results show that enforcement actions send a negative signal about banks, and depositors respond to this negative signal by transferring deposits away from non-DIF banks that are subject to enforcement actions, especially banks that are subject to severe enforcement actions.

5.5. Effect of the DIF on deposit flows on the institution-level

In Section 5.1, we show that deposits of DIF member banks increase during the financial crisis on the branch level. In this section, we check the robustness of our results on the bank-level. We also identify the type of deposits flowing to DIF member banks during the crisis.

The discussion in this section focuses on banks headquartered in Massachusetts for two reasons. First, we expect the deposit flows to occur largely within Massachusetts, so non-DIF banks headquartered in Massachusetts are the most relevant counterfactual. Second, banks in our sample generally operate in the state where their headquarter is located, limiting our sample to banks headquartered in the same state avoids the influence of unobservable time-varying state effects, which we are unable to control for in our model due to the data structure.

[TABLE 8]

Column 1 and 2 in Panel A of Table 8 document an increase in deposits of DIF member banks on the bank level. Column 1 shows a significant increase in deposits of 7.9% (*t*-statistic of 2.01) for DIF member banks during the crisis. Our result in Column 1 is robust to the inclusion of control variables, shown in Column 2. Consistent with the result in Panel B of Table 4, Column 1 and 2 in Panel B of Table 8 illustrate that the increase of deposits for DIF member banks is greater in the initial stage of the crisis, i.e., prior to the increase of the FDIC deposit insurance coverage limit and the introduction of the TAGP.

After introduction of the TAGP in Q3:2008, all noninterest-bearing transaction deposits, low-

interest Negotiable Order of Withdrawal (NOW) accounts, and Interest on Lawyers Trust Accounts (IOLTAs) are fully insured for participating banks until Q4:2010. After expiration of the TAGP, the Dodd Frank Act (DFA) provided all insured depository institutions unlimited deposit insurance coverage on noninterest-bearing transaction accounts and IOTAs, but not on low-interest NOW accounts during Q1:2011 and Q4:2012.[19]

Martin et al. (2018) show that these temporary deposit insurance measures reduce the outflow of deposits. Since noninterest-bearing deposits are already insured by the FDIC since Q3:2008, deposit inflows to DIF member banks during the crisis should mainly consist of interest-bearing deposits. The following tests confirm this is the case.

Call reports do not record NOW accounts and IOTAS independently, and they also do not separately report noninterest-bearing transaction deposits until Q1:2014. We therefore rely on noninterest-bearing deposits as a proxy of deposits insured by the TAGP.

The results in Columns 3 and 4 of Table 8 are consistent with our expectations. Column 4 shows that the increase in non-interest-bearing deposits of DIF member banks is neither significant in Panel A nor in Panel B, suggesting that noninterest-bearing deposits play a limited role in the increase of DIF member banks' deposits during the crisis. More importantly, Column 3 in Table 8 shows that the deposit inflows are largely attributable to interest-bearing deposits, the type of deposits that have not been fully insured during the crisis. The magnitudes and *t*-statistic for β_1 are similar to the results in Column 2. Based on these results, we conclude that depositors transfer deposits from non-DIF banks to DIF member banks, and the majority of the deposit inflows are interest-bearing deposits, rather than noninterest-bearing deposits.

6. Empirical Results: The effect of the DIF on bank lending

Our tests focus so far document that DIF member banks experience deposit inflows during the crisis. A natural question that arises is how do these inflows affect the asset side of the balance sheet? In this section, we first look at total lending, followed by investigations of different loan categories, a

[19] Details of the TAGP and DFA guarantees are provided at https://www.fdic.gov/regulations/resources/tlgp/.

breakdown of lending activities into different maturities, and a final analysis of mortgage orgination to better disentangle demand and supply.

6.1. Effect of the DIF on total lending, maturity structure, and loan categories

We first examine the effect on total lending, and focus on Hypothesis 2. Our tests include all control variables from Equation 1, except for the deposit interest expense ratio which we replace with the loan interest income ratio. We again use three-year lagged values of the control variables to mitigate potential endogeneity.

[TABLE 9]

Column 1 in Panel A of Table 9 presents the regression with the logarithm of total lending as the dependent variable. We find that DIF member banks increase total loans by 6.8% (*t-statistic* 2.24) relative to non-DIF banks, suggesting that they lend more during the crisis. The deposit inflows of DIF members plausibly explain the increase in lending because Ivashina and Scharfstein (2010) argue that banks with better access to deposits cut lending less during the crisis.

Next, we show a breakdown by maturity structure. The effect on different maturities is not clear. On one hand, it is plausblie that DIF member banks try to preserve liquidity through lending only at shorter maturities, suggesting that they contribute less to liquidity creation. On the other hand, DIF member banks may be prone to originate loans with longer maturities, given that the DIF minimizes the possibility of depositor runs. This view reflects predictions by Hakenes and Schliephake (2019) who posit that banks with a higher deposit base enjoy more stable funding and are less vulnerable to runs which leads to more long-term investment. The unlimited insurance coverage of private deposit insurance might serve as an alternative mechanism to strengthen its members' deposit base during the financial crisis and eventually lead to more long-term lending.

We separate total loans into loans with maturity between 5-15 years and loans with maturity below 5 years in Columns 2 and 3 in Panel A of Table 9. DIF member banks significantly increase longer-term loans by 33% (*t*-statistic 3.22) relative to non-DIF banks. There are no significant effects on loans with a maturity less than 5. These findings support the view that deposit insurance offered by

the DIF does not only minimize liquidity risk for DIF member banks, but also encourages long-term lending.

Our next set of tests investigates loan categories. We classify loans in terms of four major categories: residential mortgages, construction loans, commercial and industrial loans, and individual loans. These categories account for 86% of total lending of our sample banks. The results in Panel B of Column 1 in Table 9 show that DIF member banks increase residential mortgage lending by 8.11% (*t*-statistic 2.06) during the financial crisis. However, there is no evidence that DIF member banks increase other types of loans. The crisis is largely driven by defaults of subprime mortgages (Acharya and Richardson (2009)). It is therefore plausible that banks are more reluctant to offer residential mortgages during the crisis. Along with the deposit inflows of DIF member banks, our result show that DIF member banks are less conservative in residential mortgage lending during the crisis.

6.2 Effect of the DIF on mortgage origination

A potential criticism to our results in Section 6.1 may be that they are driven by demand effects, because our previous tests cannot disentangle demand and supply for bank lending. To rectify this, we now examine loan-level data collected by the Federal Reserve under provisions of the Home Mortgage Disclosure Act (HMDA).[20] Loan-level data of HMDA record the year of the loan application, lender identity, borrower characteristics, the loan amount, and the approval result.[21] Using the data allow controlling for credit risk through the applicant's income. Apart from income, we also control for demographic characteristics of loan applicants, including sex, race and ethnicity. We further control for economic conditions of property location through year-varying Metropolitan Statistical Areas (MSAs) fixed effects. Finally, we combine the HMDA data with the bank-level data to control for bank size, the Tier 1 capital ratio, and the charge off ratio.

[TABLE 10]

[20] The Home Mortgage Disclosure Act (HMDA) was enacted by Congress in 1975. It aims to (i) determine whether financial institutions are serving the housing needs of their communities; (ii) assist public officials in distributing public-sector investments; and (iii) identify possible discriminatory lending patterns.

[21] HMDA only reports the rate spread for loans with spreads above designated thresholds, therefore, rate spreads are reported for some, but not all mortgages. This characteristic of the data hinders further analyses regarding the effect of DIF on the mortgage spread rate during the crisis.

Table 10 presents the results. We report three different specifications, and each specification is estimated for a samples of all mortgages, and a sample that excludes mortgages for refinancing.

The results in Columns 1 to 3 show that mortgage applications to DIF member banks are more likely to be approved during the crisis, irrespective of the specification. Controlling for credit risk, borrower characteristics, economic conditions, and bank characteristics does not alter these inferences. Our findings are also robust to the exclusion of refinancing mortgages, shown in Columns 4 to 6. Importantly, the coefficient of interest is significantly larger after we exclude refinancing mortgages. In sum, the HMDA data support Hypothesis 2, even after controlling for local demand factors and loan-level characteristics.

7. Conclusion

We use the recent financial crisis to study the role of private deposit insurance, and raise two questions. First, does a privately-funded and privately-organized deposit insurance fund provide its members better access to deposits during a crisis? Second, does access to private deposit insurance allow banks to increase lending during a crisis? Both questions are important because private deposit insurance may provide stability for the banking system and the economy as a whole.

Focusing on the DIF in Massachusetts, we show that the private deposit insurance fund provides additional protection for depositors' wealth during the recent financial crisis. Depositors transfer their deposits to member banks of the DIFt the expense of banks whose deposits are only protected by federal deposit insurance. Second, the privately insured banks increase lending during the financial crisis. This finding is particularly strong for residential mortgage lending and for loans with longer maturities.

Our research is timely and important for at least two reasons. First, this work illuminates the current debate in Europe, where policy initiatives are under way to establish the third pillar of the European Banking Union, the European Deposit Insurance Scheme. Our results suggest that depositors can differentiate between different types of insurance available to them which carries the risk that

countries with lower deposit insurance coverage may experience deposit outflows during crises. Therefore, harmonizing deposit insurance schemes under a European Deposit Insurance Scheme has potential to mitigate destabilizing deposit outflows. Second, our findings also suggest that banks that have better access to deposits are less vulnerable to short-term funding risks during crises. Therefore, these results provide insights into the importance of deposits during crises and support the establishment of the net stable funding ratio and liquidity coverage ratio requirement under Basel III.

While our research illustrates the benefits of private deposit insurance, we emphazise that these findings do not suggest that private deposit insurance is a panacea. We temper our summary by highlighting that the credibility of a private deposit insurance scheme does not only depend on its characteristics, but also on the institutional environment of a country. Our result may not be applicable to countries with weak institutional environments. Under weak institutional environments, a private deposit insurance fund may amplify adverse selection, moral hazard, and fraud.

References

Acharya, V. V., and D. Skeie, (2011) 'A model of liquidity hoarding and term premia in inter-bank markets', *Journal of Monetary Economics,* Vol. 58, pp. 436-447.

Acharya, V. V., and M. Richardson (2009) 'Causes of the financial crisis', *Critical Review,* Vol. 21, pp. 195-210.

Acharya, V. V., and N. Mora (2015) 'A crisis of banks as liquidity providers', *Journal of Finance,* Vol. 70, pp. 1-43.

Angrist, J. D., and J. S. Pischke (2008) 'Mostly harmless econometrics: An empiricist's companion', *Princeton university press.*

Bayazitova, D., and A. Shivdasani (2011) 'Assessing tarp',.*Review of Financial Studies,* Vol. 25, pp. 377-407.

Beck, T. (2002) 'Deposit insurance as private club: is Germany a model?', *Quarterly Review of Economics and Finance,* Vol. 42, pp. 701-719.

Berger, A. N., and C. H. Bouwman (2013) 'How does capital affect bank performance during financial crises?', *Journal of Financial Economics,* Vol. 109, pp. 146-176.

Berger, A. N., and R. A. Roman (2015) 'Did TARP banks get competitive advantages?', *Journal of Financial and Quantitative Analysis,* Vol. 50, pp. 1199-1236.

Bernanke, B. S. (1983) 'Non-monetary effects of the financial crisis in the propagation of the Great Depression', *American Economic Review,* Vol. 73, pp. 257-276.

Bradley, C., and V. V. Craig (2007) 'Privatizing Deposit Insurance: Results of the 2006 FDIC Study', *FDIC Quarterly,* Vol. 1, pp. 23-32.

Bryant, J. (1980) 'A model of reserves, bank runs, and deposit insurance', *Journal of Banking and Finance,* Vol. 4, pp. 335- 344.

Calomiris, C. W. (1990) 'Is deposit insurance necessary? A historical perspective', *Journal of Economic History,* Vol. 50, pp. 283-295.

Calomiris, C. W. (1989) 'Deposit insurance: lessons from the record', *Economic Perspectives,* Vol. 13, pp. 10-30.

Danisewicz, P., D. McGowan, E. Onali, and K. Schaeck (2018) 'The real effects of banking supervision: Evidence from enforcement actions', *Journal of Financial Intermediation,* Vol. 35, pp. 86-101.

Degryse, H., and S. Ongena (2005), 'Distance, lending relationships, and competition', *Journal of Finance,* Vol. 60, pp. 231-266.

Delis, M. D., P. K. Staikouras, and C. Tsoumas (2016). 'Formal enforcement actions and bank behavior', *Management Science,* Vol. 63, pp. 959-987.

Dell'Ariccia, G., E. Detragiache, and R. Rajan (2008) 'The real effect of banking crises', *Journal of*

Financial Intermediation, Vol. 17, pp. 89-112.

Demirgüç-Kunt, A., E. Kane, and L. Laeven (2015) 'Deposit insurance around the world: A comprehensive analysis and database', *Journal of Financial Stability*, Vol. 20, pp. 155-183.

Diamond, D. W., and P. H. Dybvig. (1983) 'Bank runs, deposit insurance, and liquidity', *Journal of Political Economy*, Vol. 91, pp. 401-419.

England, C. (1985) 'A proposal for introducing private deposit insurance', *Federal Reserve Bank of Chicago Proceedings*, Vol. 73.

English, W. B. (1993) 'The decline of private deposit insurance in the United States', *Carnegie-Rochester Conference Series on Public Policy*, Vol. 38, pp. 57-128.

Gatev, E., and P. E. Strahan (2006) 'Banks' advantage in hedging liquidity risk: Theory and evidence from the commercial paper market', *Journal of Finance*, Vol. 61, pp. 867-892.

Gatev, E., T. Schuermann, and P. E. Strahan (2007) 'Managing bank liquidity risk: How deposit-loan synergies vary with market conditions', *Review of Financial Studies*, Vol. 22, pp. 995-1020.

Gibson, M. S. (1995) 'Can bank health affect investment? Evidence from Japan' *Journal of Business'*, Vol. 68, pp. 281-308.

Hakenes, H., and E. Schiephake (2019). Bank stability and the allocation of liquidity in the banking system. Working paper, University of Bonn.

Iyer, R., and M. Puri (2012). 'Understanding bank runs: The importance of depositor-bank relationships and networks', *American Economic Review*, Vol. 102, pp. 1414-45.

Iyer, R., M. Puri, and N. Ryan (2016). A tale of two runs: Depositor responses to bank solvency risk. *Journal of Finance*, Vol. *71*, pp. 2687-2726.

Ivashina, V., and D. Scharfstein (2010) 'Bank lending during the financial crisis of 2008', *Journal of Financial Economics*, Vol. 97, pp. 319-338.

Jordan, J. S., J. Peek, and E. S. Rosengren (2000) 'The market reaction to the disclosure of supervisory actions: Implications for bank transparency', *Journal of Financial Intermediation*, Vol. 9, pp. 298-319.

Keeley, M. C. (1990) 'Deposit insurance, risk, and market power in banking', *American Economic Review*, Vol. 80, pp.1183-1200.

Martin, C., M. Puri, and A. Ufier (2018) 'Deposit Inflows and Outflows in Failing Banks', The Role of Deposit Insurance', *National Bureau of Economic Research.*

Ongena, S., D. C. Smith, and D. Michalsen (2003) 'Firms and their distressed banks: lessons from the Norwegian banking crisis', *Journal of Financial Economics*, Vol. 67, pp. 81-112.

Paternoster, R., R. Brame., P. Mazerolle., and A. Piquero (1998) 'Using the correct statistical test for the equality of regression coefficients', *Criminology*, Vol. 36, pp. 859-866.

Peek, J., and E. S. Rosengren (2000) 'Collateral damage: Effects of the Japanese bank crisis on real activity in the United States', *American Economic Review*, Vol. 90, pp. 30-45.

Pennacchi, G. (2006) 'Deposit insurance, bank regulation, and financial system risks', *Journal of Monetary Economics*, Vol. 53, pp. 1-30.

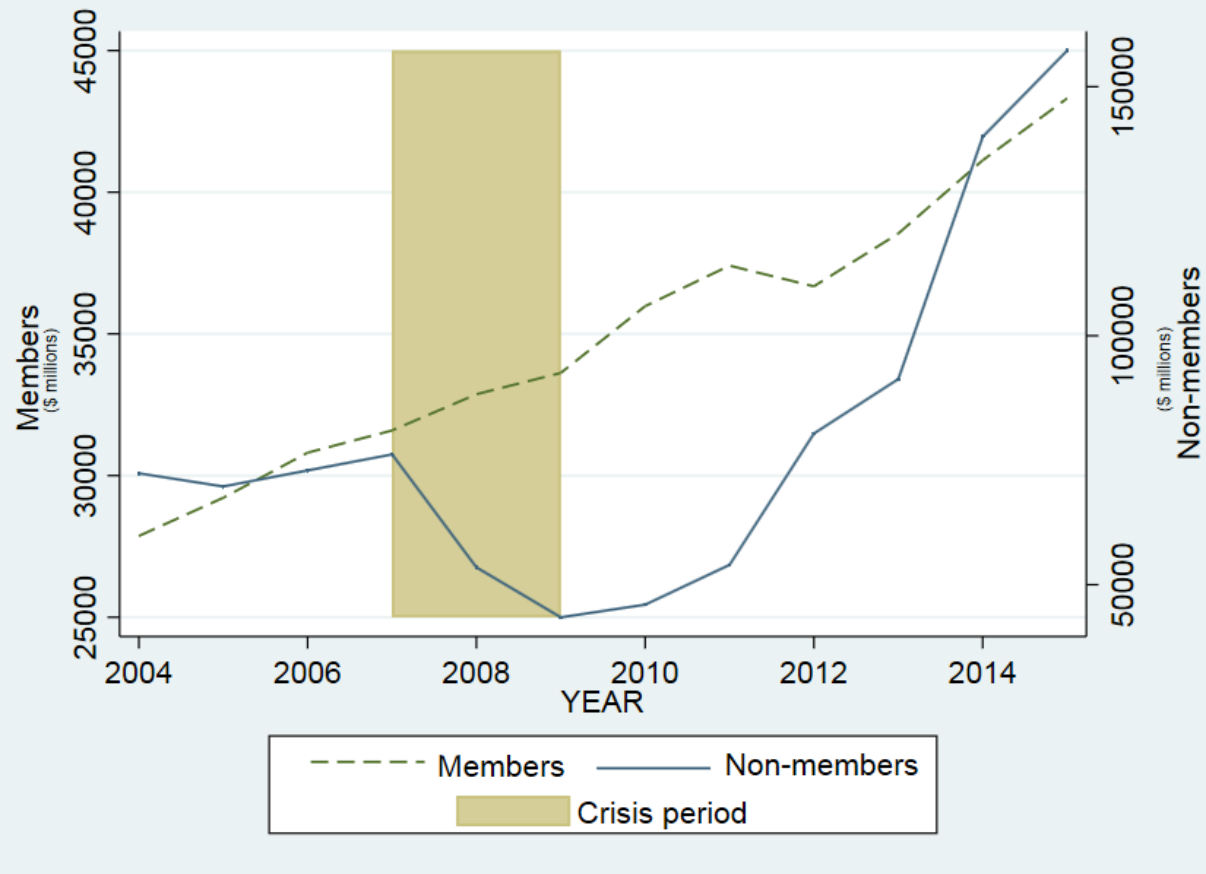
Roberts, M. R., and T. M. Whited (2013) 'Endogeneity in Empirical Corporate Finance', *Handbook of the Economics of Finance*, Vol. 2, pp. 493-572.

White, E. N. (1981) 'State-sponsored insurance of bank deposits in the United States, 1907–1929', *Journal of Economic History*, Vol. 41, pp. 537-557.

Tables and figures

Figure 1

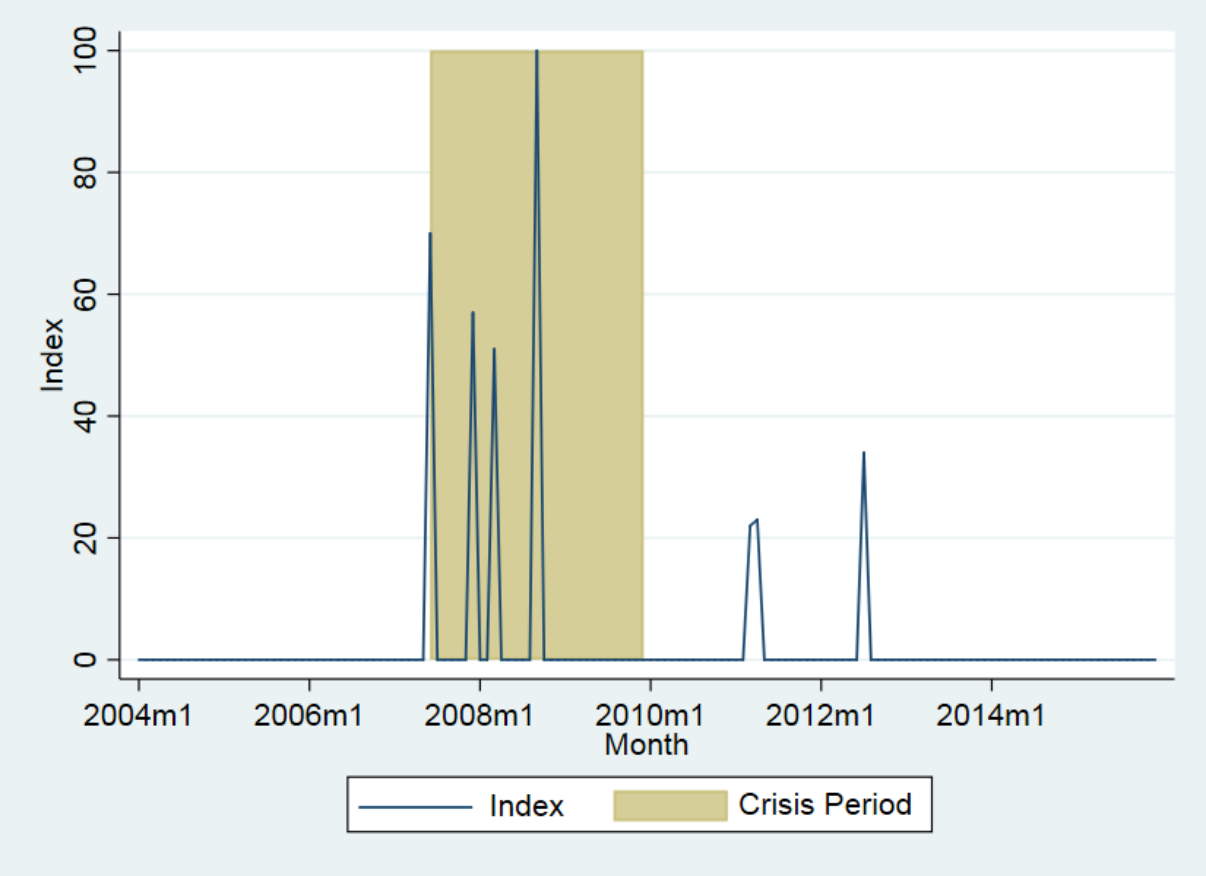
Total Deposits of the Depositors Insurance Fund members and non-members headquartered in Massachusetts in 2004-2015



Notes. Figure 1 presents total deposits of DIF member banks and non-DIF banks headquartered in Massachusetts, the shaded period indicates the crisis period. Total deposits are scaled by 1,000,000.

Figure 2

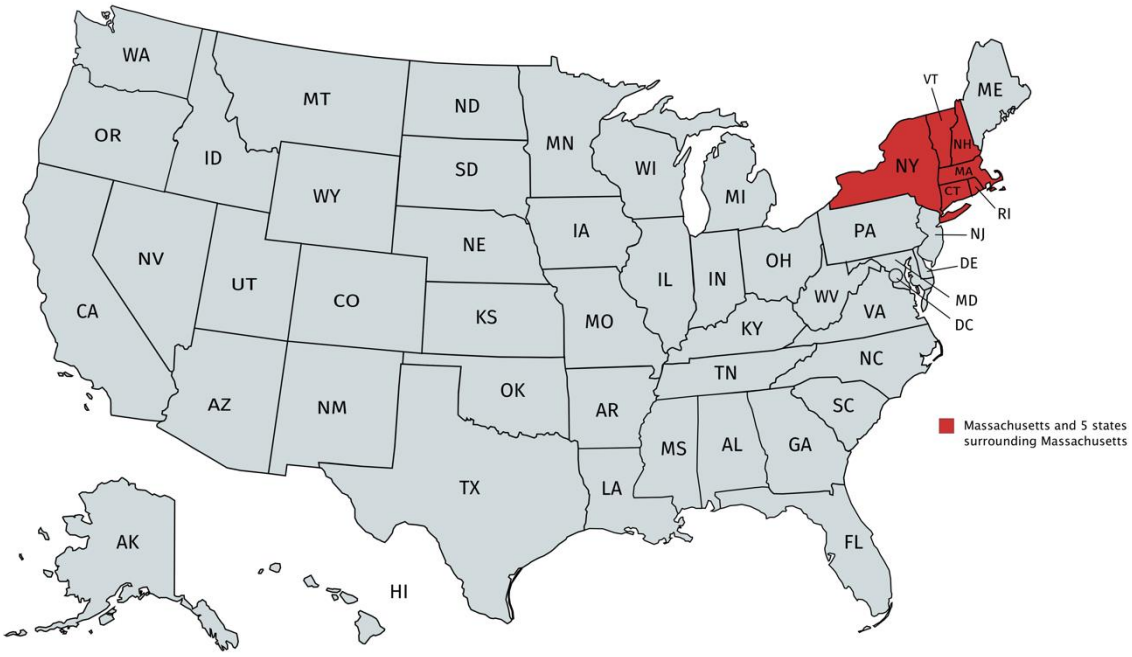
Google Trends search volume index of the keyword "Depositors Insurance Index"



Notes. Figure 2 presents Google Trends search volume index of the keywords "Depositors Insurance Fund" in Massachusetts during 2004 and 2015.

Figure 3

Geographic location of Massachusetts



Notes. Figure 3 shows the geographic location of Massachusetts (MA). Connecticut (CT), New Hampshire (NH), New York (NY), Rhode Island (RI) and Vermont (VT) are five states surrounding Massachusetts.

Figure 4

Timeline of government responses during the crisis

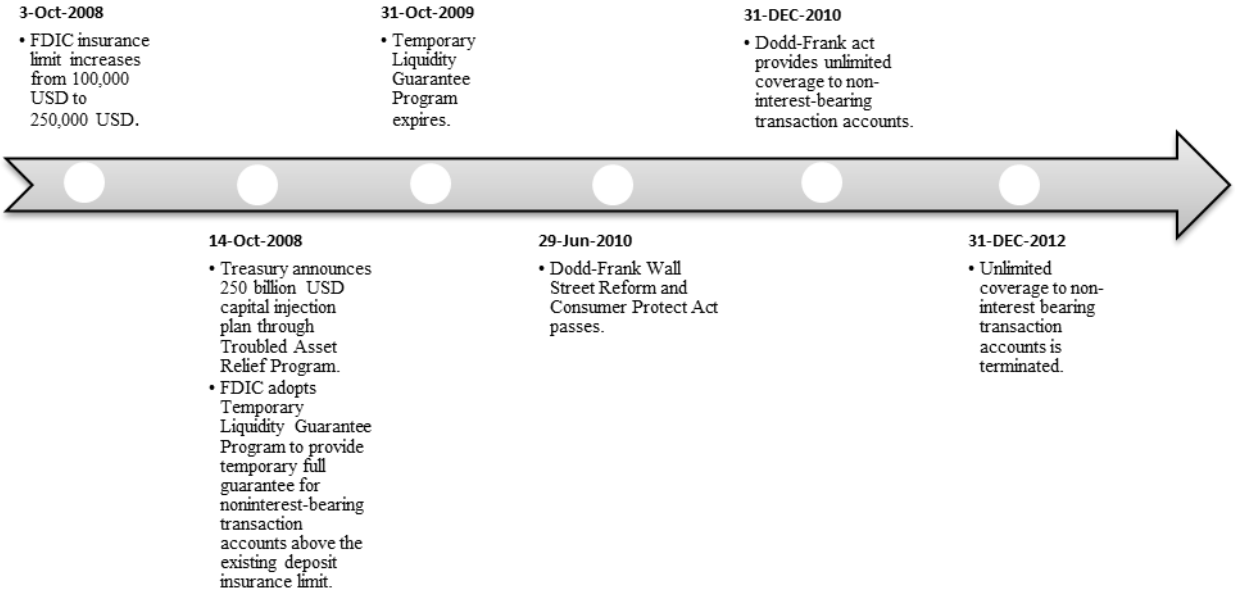


Table 1

Comparison between the DIF and other deposit insurance funds

Panel A

Deposit insurance / Characteristics	DIF	FDIC
Explicit	Yes	Yes
Coverage limit	Unlimited	250,000 USD
Coinsurance	No	No
Sources of funds	Banks only	Banks and the government
Management	Private	Public
Membership	Voluntary	Compulsory
Risk adjusted premium	Yes	Yes

Panel B

Deposit insurance / Characteristics	Successful in the pre-FDIC period	Failed in the pre-FDIC period	The DIF
Mutual liabilities among member	Yes	No	Yes
Power to regulate and discipline banks	Yes	No	Yes
Reserve to cover insured deposits	Abundant	Limited	Abundant
Management primarily comprises of member banks' management	Yes	No	Yes
Risk adjusted premium	Yes	No	Yes

Notes. Panel A of Table 1 compares characteristics of the DIF and the FDIC. Panel B of Table 1 compares characteristics of deposit insurance provided by the DIF to successful deposit insurance and failed deposit insurance in U.S. history.

Table 2

Descriptive statistics

Panel A					
Summary statistics for banks in Massachusetts					
Dependent variables:	N	mean	sd	p5	p95
Branch level deposits	13,189	144,268	1,801,583	10,141	212,853
Institutional level deposits	3,449	894,831	3,066,610	91,949	2,343,364
Interest-bearing deposits	3,449	682,588	1,528,540	71,148	2,022,918
Non-interest-bearing deposits	3,449	212,243	2,079,951	7,166	427,704
Total loans	3,449	667,109	1,652,194	74,926	1,943,551
Loans with maturity between 5 years and 15 years	3,449	101,526	337,132	3,254	344,918
Loans with maturity below 5 years	3,449	316,732	1,137,241	13,559	876,895
Residential mortgages	3,449	336,703	643,018	30,017	993,067
Construction loans	3,449	31,511	48,767	725	124,743
Commercial and industrial loans	3,449	66,163	327,723	1,053	233,254
Individual loans	3,449	39,376	380,990	378	87,170
Independent variables:					
Total assets	3,449	1,386,913	7,898,941	114,507	3,027,300
Z-score (ln)	3,449	4.935	1.121	2.791	6.624
Tier 1 capital ratio (%)	3,449	9.864	2.701	6.500	14.522
Charge-off ratio (%)	3,449	0.035	0.086	0.000	0.159
Interest expense ratio (%)-deposits	3,449	0.499	0.242	0.157	0.924
Interest income ratio (%)-total loans	3,449	1.488	0.229	1.145	1.880

Panel B			
Dependent variables	Non-member	Member	Difference
Institutional level deposits	581,919	514,239	67,681
Interest-bearing deposits	540,425	475,211	65,214
Non-interest-bearing deposits	41,495	39,028	2,467
Total loans	529,176	436,820	92,356
Loans with maturity over a year	76,595	54,894	21,701
Loans with maturity less than a year	246,682	148,420	98,262
Residential mortgages	315,230	280,427	34,803
Construction loans	80,041	59,883	20,158
Commercial and industrial loans	46,125	25,252	20,873
Individual loans	39,705	12,468	27,236
Independent variables:			
Total assets	827,285	670,708	156,577
Z-score	4.078	4.201	0.123
Tier 1 capital ratio (%)	0.120	0.108	0.012
Charge off ratio (%)	0.03	0.012	0.018
Interest expense ratio (%)-deposits	0.896	0.809	0.087***
Interest income ratio (%)-total loans	1.699	1.56	0.138***

Notes. Panel A of Table 2 presents summary statistics by using a sample covering branches operating in Massachusetts and banks operating branches in Massachusetts in 2004-2015. Panel B of Table 2 compares the mean value of different variables of DIF member banks and other savings banks in the U.S. in Q2:2007. All numbers are expressed in thousand dollars, apart from the Z-score, the interest expense ratio, the interest income ratio, the charge off ratio and the Tier 1 capital ratio. All variables are winsorized at the 1% level and 99% level. *** p<0.01, ** p<0.05, * p<0.1.

Table 3

Difference in quarterly growth rate of dependent variables between DIF member banks and non-DIF banks

Time	2004	2005	2006	2007
Variables	Difference	Difference	Difference	Difference
Δ Branch level deposits (ln)	-0.000	0.001	0.001	0.002
	(-0.16)	(0.60)	(0.83)	(1.41)
Time	Q3:06	Q4:06	Q1:07	Q2:07
Variables	Difference	Difference	Difference	Difference
Δ Institutional level deposits (ln)	0.002*	0.001	0.001	0.002
	(1.74)	(0.77)	(1.48)	(1.40)
Δ Interest-bearing deposits (ln)	0.002**	0.000	0.002	0.003
	(2.04)	(0.26)	(0.85)	(1.24)
Δ Non-interest-bearing deposits (ln)	-0.000	0.004	0.003	-0.004
	(-0.16)	(1.03)	(0.89)	(-1.22)
Δ Total loans (ln)	0.001	0.002	0.003	0.002
	(0.62)	(1.63)	(1.11)	(1.40)
Δ Loans with maturity between 5 years and 15 years (ln)	0.001	-0.008	0.011	0.007
	(0.14)	(-0.66)	(0.95)	(1.01)
Δ Loans with maturity below 5 years (ln)	-0.000	0.008	0.003	0.003
	(-0.02)	(0.55)	(0.85)	(1.06)
Δ Residential mortgages (ln)	0.001	0.003	0.005	0.002
	(0.58)	(0.94)	(1.07)	(1.11)
Δ Construction loans (ln)	0.006	0.012	-0.000	-0.001
	(0.42)	(1.47)	(-0.02)	(-0.07)
Δ Commercial and industrial loans (ln)	0.002	0.002	-0.006	0.005
	(0.68)	(0.18)	(-1.48)	(0.85)
Δ Individual loans (ln)	-0.007	0.002	0.003	-0.001
	(-0.66)	(0.16)	(0.19)	(-0.12)

Notes. Table 3 shows the difference in quarterly growth rate of various dependent variables between the DIF banks and non-DIF banks headquartered in Massachusetts over different pre-crisis periods. Robust *t*-statistics are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4

Baseline result: effect of the DIF membership on branch level deposits

Panel A					
Dependent variable:			**Branch deposits (ln)**		
Sample	Full sample	Full sample	All branches in MA	MA branches operated by MA banks	MA branches of Members & Non-MA banks
	(1)	(2)	(3)	(4)	(5)
Membership*Crisis	0.018**	0.022**	0.092***	0.032**	0.083***
	(2.01)	(2.56)	(8.56)	(2.09)	(7.41)
L. Total assets (ln)		0.026***	0.054***	0.147***	0.055***
		(6.64)	(8.55)	(5.82)	(9.22)
L. Interest expense ratio (%)		0.064***	0.071***	0.146***	0.060***
		(8.88)	(4.30)	(5.87)	(3.42)
L. Charge off ratio (%)		-0.001	0.023***	-0.034*	0.077***
		(-0.43)	(2.64)	(-1.94)	(7.64)
L. Tier 1 capital ratio (%)		-0.021***	-0.013***	0.008	0.016***
		(-9.42)	(-3.35)	(1.11)	(3.36)
Branch FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
R-squared	0.192	0.207	0.339	0.321	0.401
Observations	69,108	69,108	13,189	7,098	10,369
No. of branches	7,006	7,006	1,361	888	1,149
SE Cluster	Branch	Branch	Branch	Branch	Branch
Panel B					
Membership*Crisis	0.034***	0.064***	0.166***	0.080***	0.126***
	(2.78)	(5.23)	(11.07)	(3.38)	(8.81)
L. Total assets (ln)		0.026***	0.054***	0.146***	0.056***
		(6.62)	(8.54)	(5.76)	(9.34)
L. Interest expense ratio (%)		0.065***	0.075***	0.148***	0.063***
		(9.01)	(4.53)	(5.93)	(3.60)
L. Charge off ratio (%)		-0.002	0.004	-0.037**	0.055***
		(-0.75)	(0.49)	(-2.10)	(5.61)
L. Tier 1 capital ratio (%)		-0.021***	-0.013***	0.007	0.017***
		(-9.42)	(-3.22)	(1.07)	(3.54)
Branch FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
R-squared	0.192	0.207	0.340	0.322	0.401
Observations	69,108	69,108	13,189	7,098	10,369
No. of branches	7,006	7,006	1,361	888	1,149
SE Cluster	Branch	Branch	Branch	Branch	Branch

Notes. Table 4 presents the results obtained using Eq. 1 where the dependent variable is the logarithm of branch deposits (in $000) and the main explanatory variable is an interaction term between the dummy variable for membership and the dummy variable for crisis (0 otherwise). The sample in Table A includes banks switch DIF membership status during the sample period. In Panel A, the crisis period is defined as Q3:2007-Q2:2010. In Panel B, the crisis period is defined as Q3:2007-Q2:2008. Column 1 includes full sample including branches of all banks from Massachusetts, New York, New Hampshire, Connecticut, Vermont, Rhode Island. Column 2 includes results for the same sample as in Column 1 with additional 3 years-lagged institution-level control variables. Total assets (ln) is the logarithm of total bank assets; Interest expense ratio (%) is the percentage of total interest expense over total deposits; Charge-off ratio (%) refers to the ratio of loans that are charged off over total loans; and Tier 1 capital ratio (%) indicates Tier 1 capital ratio of banks. Column 3 includes results obtained using a sample covering branches of all banks operating in Massachusetts. Column 4 includes results obtained using a sample including only Massachusetts branches of banks headquartered in Massachusetts (members and non-members of Depositors Insurance Fund). Column 5 includes results obtained using a sample in Column 3, excluding branches of banks headquartered in Massachusetts which are not members of Depositors Insurance Fund. Column 6 includes results obtained using a matched sample. Robust *t*-statistics are presented in parentheses. Standard errors are clustered at the branch level. *** p<0.01, ** p<0.05, * p<0.1.

Table 5

Effect of DIF membership on branch level deposits (with sub-samples of non-DIF banks)

Sample	All branches in MA									
Dependent variable	**Branch deposits (ln)**									
Control group split	Proportion of uninsured deposits		Interest expense ratio (%)		Tier 1 capital ratio (%)		Charge off ratio (%)		Z-score (ln)	
Percentile	≤ P50	> P50	≤ P50	> P50	≤ P50	> P50	> P50	> P50	≤ P50	> P50
Panel A										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Membership*Crisis	0.051	0.095***	0.068***	0.116***	0.094***	0.053*	0.105***	0.093***	0.084***	0.059***
	(-1.59)	(8.65)	(5.13)	(-8.68)	(8.63)	(-1.93)	(4.17)	(-8.43)	(5.97)	(-4.40)
L. Total assets (ln)	0.160***	0.053***	0.049***	0.069***	0.053***	0.174***	0.122***	0.058***	0.077***	0.025**
	(-5.92)	(8.36)	(3.35)	(-11.28)	(8.13)	(-6.16)	(5.81)	(-8.86)	(11.51)	(-2.18)
L. Interest expense ratio (%)	0.120***	0.066***	0.090***	0.061***	0.036**	0.151***	0.180***	0.037**	0.103***	0.091***
	(-4.12)	(3.82)	(3.73)	(-3.22)	(2.08)	(-5.62)	(6.14)	(-2.17)	(4.37)	(-4.35)
L. Charge off ratio (%)	-0.023	0.026***	-0.004	0.040***	0.023**	0.048*	-0.011	0.025***	0.094***	-0.046***
	(-1.36)	(2.87)	(-0.20)	(-4.13)	(2.56)	(-1.7)	(-0.67)	(-2.79)	(8.05)	(-4.09)
L. Tier 1 capital ratio (%)	0.001	-0.013***	-0.003	-0.021***	-0.013***	0.003	0.012	-0.016***	0.014**	-0.019***
	(-0.11)	(-3.04)	(-0.42)	(-4.68)	(-2.94)	(-0.53)	(1.56)	(-4.10)	(2.21)	(-4.24)
Test of difference in coefficient *p*-value (two-tailed)	0.097		0.011		0.011		0.662		0.011	
Branch FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.305	0.342	0.311	0.346	0.327	0.362	0.336	0.334	0.400	0.294
Observations	5,048	12,419	7,201	10,266	12,430	5,037	5,099	12,368	7,980	9,487
No. of branches	494	1,276	689	1,081	1,280	490	506	1,264	788	982
SE Cluster	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Panel B										
Membership*Crisis	0.093**	0.167***	0.112***	0.212***	0.166***	0.121***	0.145***	0.167***	0.110***	0.145***
	(-2.42)	(11.10)	(5.35)	(-12.99)	(10.72)	(-3.61)	(4.47)	(-11.03)	(6.77)	(-6.99)
L. Total assets (ln)	0.158***	0.053***	0.048***	0.069***	0.053***	0.172***	0.117***	0.058***	0.078***	0.024**
	(-5.83)	(8.35)	(3.25)	(-11.21)	(8.13)	(-6.15)	(5.51)	(-8.94)	(11.39)	(-2.11)
L. Interest expense ratio (%)	0.119***	0.070***	0.099***	0.053***	0.042**	0.153***	0.181***	0.041**	0.094***	0.106***
	(-4.15)	(4.08)	(3.95)	(-2.72)	(2.39)	(-5.71)	(6.13)	(-2.40)	(3.99)	(-5.06)
L. Charge off ratio (%)	-0.026	0.005	-0.018	0.005	0.001	0.039	-0.022	0.003	0.070***	-0.058***
	(-1.54)	(0.59)	(-0.95)	(-0.61)	(0.10)	(-1.46)	(-1.32)	(-0.35)	(6.17)	(-5.62)
L. Tier 1 capital ratio (%)	0.000	-0.012***	-0.005	-0.019***	-0.012***	0.003	0.011	-0.015***	0.015**	-0.018***
	(-0.02)	(-2.84)	(-0.60)	(-4.39)	(-2.76)	(-0.50)	(1.38)	(-3.87)	(2.52)	(-4.01)
Test of difference in coefficient *p*-value (two-tailed)	0.036		0.000		0.000		0.539		0.000	
Branch FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.302	0.345	0.311	0.348	0.328	0.363	0.336	0.336	0.399	0.296
Observations	5,048	12,419	7,201	10,266	12,430	5,037	5,099	12,368	7,980	9,487
No. of branches	494	1,276	689	1,081	1,280	490	506	1,264	788	982
SE Cluster	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes. Table 5 presents the results obtained using Eq. 1 where the dependent variable is the logarithm of branch deposits (in $000) and the main explanatory variable is an interaction term between the dummy variable for membership and the dummy variable for crisis (0 otherwise). The sample in Table A includes banks switch DIF membership status during the sample period. In Panel A, the crisis period is defined as Q3:2007-Q2:2010. In Panel B, the crisis period is defined as Q3:2007-Q2:2008. Column 1 presents results with a control group that has lower exposure to uninsured deposits during the pre-crisis period. Column 2 presents results with a control group that has higher exposure to uninsured deposits during the pre-crisis period. Column 3 presents results with a control group that has lower interest expense ratio during the pre-crisis period. Column 4 presents results with a control group that has higher interest expense ratio during the pre-crisis period. Column 5 presents results with a control group that has lower Tier 1 capital ratio during the pre-crisis period. Column 6 presents results with a control group that has higher Tier 1 capital ratio during the pre-crisis period. Column 7 presents results with a control group that has higher charge off ratio during the pre-crisis period. Column 8 presents results with a control group that has lower charge off ratio during the pre-crisis period. Column 9 presents results with a control group that has higher Z-score. Column 10 presents results with a control group that has lower Z-score during the pre-crisis period. Definitions of all control variables are shown in the notes of Table 4. *p*-value for the test of difference in the coefficient of interest is shown at the bottom of each pair of columns. The null hypothesis of the equality test is that the difference between the pair of the coefficient of interest equals to zero. Robust *t*-statistics are presented in parentheses. Standard errors are clustered at the branch level. *** p<0.01, ** p<0.05, * p<0.1.

Table 6

Auxiliary regression for DIF membership

Dependent variable	Membership	
Sample	All banks headquartered in MA	All banks operating branches in MA
	(1)	(2)
Enforcement actions during the crisis	-0.488	-0.838
	(-0.37)	(-0.79)
Severe enforcement action during the crisis	-0.969	-0.457
	(-0.55)	(-0.28)
Average charge off ratio during the crisis	0.585	-1.123
	(0.33)	(-1.42)
Average Z-score(ln) during the crisis	0.347	0.160
	(0.99)	(0.50)
R-squared	0.037	0.097
Banks	83	100

Notes. Table 6 presents the results obtained using Eq. 3 where the dependent variable is the DIF membership status of banks in 2007 and the explanatory variables include a dummy variable indicating whether banks are subject to enforcement action during the crisis, a dummy variable indicating whether banks are subject to severe enforcement action during the crisis, average charge off ratio during the crisis, average Z-score during the crisis. Column 1 shows the results with the sample of all banks headquartered in Massachusetts, while Column 2 shows the results with the sample of all banks operating branches in Massachusetts. Robust *t*-statistics are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7

Influence of the TARP and enforcement actions on the effect of the DIF membership

Panel A						
Sample	All branches in MA					
Dependent variable	**Branch deposits (ln)**					
Control group	TARP Banks	Non-TARP	EAs Banks	Non-EAs Banks	Severe EAs Banks	Less-severe EAs Banks
	(1)	(2)	(3)	(4)	(5)	(6)
Membership*Crisis	0.068***	0.042***	0.108***	0.039**	0.131***	0.096***
	(4.84)	(3.67)	(9.24)	(2.25)	(8.43)	(6.76)
L. Total assets (ln)	0.075***	0.026**	0.058***	0.150***	0.081***	0.028**
	(11.39)	(2.21)	(8.74)	(5.08)	(13.09)	(2.17)
L. Interest expense ratio (%)	0.102***	0.093***	0.029	0.158***	0.019	0.069***
	(4.66)	(4.26)	(1.60)	(6.36)	(0.83)	(2.82)
L. Charge off ratio (%)	0.089***	-0.058***	0.035***	-0.022	0.053***	0.019
	(7.71)	(-5.99)	(3.94)	(-1.24)	(5.37)	(0.84)
L. Tier 1 capital ratio (%)	0.024***	-0.021***	-0.016***	0.001	-0.027***	0.004
	(3.60)	(-4.83)	(-3.69)	(0.12)	(-5.16)	(0.56)
Test of difference in coefficient *p*-value (two-tailed)	0.151		0.001		0.096	
Branch FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
R-squared	0.427	0.278	0.328	0.355	0.325	0.326
Observations	7,941	9,526	11,817	5,650	9,645	6,450
No. of branches	808	962	1,222	548	985	646
SE Cluster	Branch	Branch	Branch	Branch	Branch	Branch
Panel B						
Membership*Crisis	0.116***	0.104***	0.178***	0.090***	0.214***	0.132***
	(7.33)	(5.67)	(10.79)	(4.23)	(11.21)	(5.54)
L. Total assets (ln)	0.075***	0.026**	0.059***	0.148***	0.084***	0.026*
	(11.22)	(2.20)	(8.82)	(5.00)	(13.43)	(1.95)
L. Interest expense ratio (%)	0.095***	0.102***	0.036**	0.159***	0.005	0.081***
	(4.30)	(4.58)	(1.97)	(6.42)	(0.23)	(3.17)
L. Charge off ratio (%)	0.066***	-0.067***	0.009	-0.025	0.010	-0.002
	(5.97)	(-7.16)	(1.02)	(-1.45)	(1.07)	(-0.08)
L. Tier 1 capital ratio (%)	0.025***	-0.021***	-0.015***	0.000	-0.024***	0.002
	(3.86)	(-4.70)	(-3.34)	(0.05)	(-4.75)	(0.30)
Test of difference in coefficient *p*-value (two-tailed)	0.620		0.001		0.007	
Branch FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
R-squared	0.428	0.280	0.328	0.356	0.326	0.324
Observations	7,941	9,526	11,817	5,650	9,645	6,450
No. of branches	808	962	1,222	548	985	646
SE Cluster	Branch	Branch	Branch	Branch	Branch	Branch

Notes. Table 7 presents the results obtained using Eq. 1 where the dependent variable is the logarithm of branch deposits (in $000) and the main explanatory variable is an interaction term between the dummy variable for membership and the dummy variable for crisis (0 otherwise). The sample in Table A includes banks switch DIF membership status during the sample period. In Panel A, the crisis period is defined as Q3:2007-Q2:2010. In Panel B, the crisis period is defined as Q3:2007-Q2:2008. Column 1 presents results with a control group including members of Multi-Banks Holding Companies (MBHC). Column 2 presents results with a control group presents results with a control group including members of One-Banks Holding Companies (OBHC). Column 1 presents results with a control group of banks that participate the TARP. Column 2 presents results with a control group of banks that are not participants of the TARP. Column 3 presents results with a control group of banks that are subject to enforcement actions during the crisis period. Column 4 presents results with a control group of banks that are not subject to enforcement actions during the crisis period. Column 5 presents results with a control group of banks that are subject to severe enforcement actions during the crisis period. Column 6 presents results with a control group of banks that are not subject to less severe enforcement actions during the crisis period. The *p*-value for the test of difference in the coefficient of interest is shown at the bottom of each pair of columns. The null hypothesis of the equality test is that the difference between the pair of the coefficient of interest equals to zero. Definitions of all control variables are shown in the notes of Table 4. Robust *t*-statistics are presented in parentheses. Standard errors are clustered at the branch level. *** p<0.01, ** p<0.05, * p<0.1.

Table 8

Effect of the DIF membership on institutional level deposits

Dependent variables	**Institutional Deposits (ln)**	**Institutional Deposits (ln)**	**Interest-bearing deposits (ln)**	**Non-interest-bearing deposits (ln)**
Panel A				
	(1)	(2)	(3)	(4)
Membership*Crisis	0.076**	0.078**	0.082**	-0.025
	(2.01)	(2.58)	(2.49)	(-0.33)
L. Total assets (ln)		0.736***	0.697***	0.954***
		(10.77)	(9.61)	(5.96)
L. Interest expense ratio (%)		-0.005	-0.006	-0.088
		(-0.05)	(-0.05)	(-0.25)
L. Charge off ratio (%)		-0.004	0.000	-0.031
		(-0.07)	(0.00)	(-0.20)
L. Tier 1 capital ratio (%)		0.024***	0.021***	0.040***
		(4.33)	(3.33)	(2.96)
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R-squared	0.534	0.642	0.631	0.520
Observations	3,449	3,449	3,449	3,449
No. of banks	83	83	83	83
SE Cluster	Bank	Bank	Bank	Bank
Panel B				
Membership*Crisis	0.089**	0.081**	0.078**	0.103
	(2.16)	(2.42)	(2.30)	(1.07)
L. Total assets (ln)		0.738***	0.699***	0.952***
		(10.60)	(9.48)	(5.95)
L. Interest expense ratio (%)		-0.021	-0.022	-0.085
		(-0.18)	(-0.19)	(-0.24)
L. Charge off ratio (%)		-0.008	-0.004	-0.031
		(-0.13)	(-0.07)	(-0.20)
L. Tier 1 capital ratio (%)		0.025***	0.022***	0.040***
		(4.17)	(3.24)	(2.89)
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R-squared	0.521	0.640	0.625	0.510
Observations	3,449	3,449	3,449	3,449
No. of banks	83	83	83	83
SE Cluster	Bank	Bank	Bank	Bank

Notes. Table 8 presents the results obtained using Eq. 2 with institutional level data of Massachusetts banks in 2004 -2015 and the main explanatory variable is an interaction term between dummy variable Membership and Crisis. In Panel A, crisis period is defined as Q3:2007-Q2:2010. In Panel B, crisis period is defined as Q3:2007-Q2:2008. The dependent variable in Column1 and Column2 is the logarithm of institutional deposits (in $000), while Column 2 includes results with additional time-lagged institution-level control variables. The dependent variable in Column 3 is a logarithm of interest-bearing deposits (in $000). The dependent variable in Column 4 is a logarithm of noninterest-bearing deposits (in $000). Definitions of all control variables are shown in the notes of Table 4. Robust *t*-statistics are presented in parentheses. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 9

Effect of the DIF membership on lending

Panel A

Dependent variables	**Total loans**	**Loans with maturity between 5-15 years**	**Loans with maturity below 5 years**
	(1)	(2)	(3)
Membership*Crisis	0.066**	0.286***	-0.024
	(2.24)	(3.22)	(-0.42)
L. Total assets (ln)	0.717***	0.640***	0.546***
	(8.35)	(2.67)	(3.45)
L. Interest income ratio (%)	-0.064	0.265	-0.088
	(-0.69)	(0.96)	(-0.68)
L. Charge off ratio (%)	0.017	-0.094	-0.031
	(0.23)	(-0.66)	(-0.32)
L. Tier 1 capital ratio (%)	0.014**	-0.003	0.015
	(2.21)	(-0.13)	(1.07)
Bank FE	YES	YES	YES
Year FE	YES	YES	YES
R-squared	0.641	0.632	0.658
Observations	3,449	3,449	3,449
No. of banks	83	83	83
SE Cluster	Bank	Bank	Bank

Panel B

Dependent variables	**Residential mortgages**	**Construction and land development loans**	**Commercial and industrial loans**	**Individual loans**
	(1)	(2)	(3)	(4)
Membership*Crisis	0.078**	0.056	0.072	0.175
	(2.06)	(0.33)	(0.51)	(1.48)
L. Total assets (ln)	0.585***	0.642	0.838**	0.804***
	(5.49)	(1.43)	(2.35)	(3.11)
L. Interest income ratio (%)	-0.066	-0.471	-0.296	0.109
	(-0.68)	(-1.02)	(-1.10)	(0.35)
L. Charge off ratio (%)	0.045	-0.486**	-0.028	0.149
	(0.65)	(-2.42)	(-0.09)	(0.77)
L. Tier 1 capital ratio (%)	0.004	0.019	0.009	0.061**
	(0.39)	(0.46)	(0.43)	(2.47)
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R-squared	0.632	0.584	0.614	0.587
Observations	3,449	3,449	3,449	3,449
No. of banks	83	83	83	83
SE Cluster	Bank	Bank	Bank	Bank

Notes. Table 9 presents the results obtained using Eq. 2 with institutional level data of Massachusetts banks in 2004 -2015 and the main explanatory variables is an interaction term between dummy variable Membership and Crisis. Crisis period is defined as 2007Q3-2009Q4. In Panel A, the dependent variable in Column1 is the logarithm of total loans (in $000). The dependent variable in Column2 is a logarithm of total loans with maturity between 5-15 years (in $000). The dependent variable in Column3 is a logarithm of loans with maturity below 5 years (in $000). In Panel B, the dependent variable in Column1 is a logarithm of residential mortgages (in $000). The dependent variable in Column2 is a logarithm of construction and land development loans (in $000). The dependent variable in Column3 is a logarithm of commercial and industrial loans (in $000). The dependent variable in Column.4 is a logarithm of individual loans (in $000). Interest income ratio (%) refers to the percentage of total interest income from loans over total loans, definitions of all other control variables are shown in the notes of Table 4. Robust *t*-statistics are presented in parentheses. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table 10

Effect of the DIF membership on loan origination

Dependent variables	**Acceptance of loan applications**					
Sample	**All mortgages**			**Exclude mortgages for refinancing**		
	(1)	(2)	(3)	(4)	(5)	(6)
Membership*Crisis	0.010***	0.012***	0.012***	0.024***	0.026***	0.024***
	(3.06)	(3.31)	(3.14)	(4.71)	(4.69)	(4.20)
L. Total assets (ln)			-0.017***			-0.003
			(-4.05)			(-0.55)
L. Charge off ratio (%)			-0.017***			-0.021***
			(-3.49)			(-2.99)
L. Tier 1 capital ratio (%)			0.006***			0.007***
			(7.55)			(6.87)
Bank FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
MSA FE	NO	YES	YES	NO	YES	YES
MSA x Year FE	NO	YES	YES	NO	YES	YES
R-squared	0.048	0.055	0.062	0.047	0.057	0.063
Loan level characteristics	NO	NO	YES	NO	NO	YES
Observations	393,367	393,367	393,367	195,260	195,260	195,260
No. of banks	83	83	83	83	83	83
SE Cluster	Bank	Bank	Bank	Bank	Bank	Bank

Notes. Table 10 presents results obtained with loan-level data of Massachusetts banks in 2004 -2015 and the main explanatory variables is an interaction term between dummy variable Membership and Crisis. Crisis period is defined as 2007Q3-2009Q4. The dependent variable in Table 10 is a dummy variable indicating whether a loan application is approved. Robust *t*-statistics are presented in parentheses. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Appendix A

In this appendix, we summarize 5 common characteristics of successful and fail deposit insurance funds based on White (1981), Calmoris (1989), Calmoris (1990), and English (1993). The objective of our brief survey is to evaluate the credibility of the DIF based on historical experience of deposit insurance funds.

(i) Mutual liabilities among members

Most of the failed deposit insurance funds have limited liabilities among members, while members maintain mutual liability among each other in successful deposit insurance funds (Calomiris (1990)). Mutual liabilities among members generate incentives for peer monitoring and peer support, thus reducing the failure probability for each one of the member banks. As a result, the risk of failure for the deposit insurance fund is limited. The DIF is privately funded and operated, members of the DIF are subject to mutual liabilities among each other.

(ii) Power to regulate and discipline banks

For most of the successful deposit insurance funds, their board of directors can investigate bank operations and discipline banks. The disciplinary actions include setting limits on asset-to-capital ratios, and even bank closure upon a two-thirds majority vote of the board (Calomiris (1989)).

The management board of the DIF is less powerful, compared with the power of successful deposit insurance funds in the past. However, the management board of the DIF can adjust the assessment rate according to members' risk categories and require members to take measures to mitigate risk. In contrast to the pre-FDIC period, all DIF-insured banks are already monitored by the FDIC and the Massachusetts Division of Banks. The DIF may not need to have strong board power as it should be in the pre-FDIC period.

(iii) Cost of exit

The low cost of exit contributes to adverse selection problems which undermine the reliability of the deposit insurance fund (English (1993)). The cost of exit is high when the board of the deposit

insurance funds can restrict exit and exit undermines banks' competitive advantage. Membership of the DIF is voluntary, its members are free to exit. Moreover, the DIF banks are still insured by the FDIC after they exit the DIF. Therefore, the cost of exit for the DIF members is relatively low, compared with the successful deposit insurance systems in the U.S. history.

(iv) Reserves to cover insured deposits

A characteristic of a failed deposit insurance is limited reserves. Due to the small amount of reserves, such insurance funds run out of reserves when one of the large member banks fails or when many member banks fail simultaneously (English (1993)).

There is no objective criterion for reserve adequacy. However, the DIF was capable to cover depositors' losses when many banks failed at the same time during the Great Depression and the New England crisis. During the Great Depression, the DIF paid out more than 50 million USD to protect over 6,500 depositors in 19 failed member banks.

To illustrate the adequacy of DIF reserves, Figure A compares the gross coverage ratio of the DIF with the FDIC in 2004-2015.[23] We define the gross coverage ratio as total assets over insured deposits. The gross coverage ratio of the DIF is constantly higher than the FDIC. The gross coverage ratio of the DIF ranges from 3.5% to 6 %, while the coverage ratio of the FDIC stays below 2%. The gross coverage ratio of both institutions rises during the financial crisis. The adjustment of the FDIC deposit insurance limit causes a sharp increase in the gross coverage ratio of the DIF in 2008. Although the DIF and the FDIC are not directly comparable, the gross coverage ratio reveals that the DIF is not under threat during the recent financial crisis.

[FIGURE A]

(v) Risk adjusted premium

A flat rate insurance premium is known to give rise to moral hazard (Keeley (1990)). In the absence of effective regulations and enforcement actions, a flat rate insurance scheme subsidizes banks'

[23] Information on the gross coverage ratio of the DIF and the FDIC is available on their annual report.

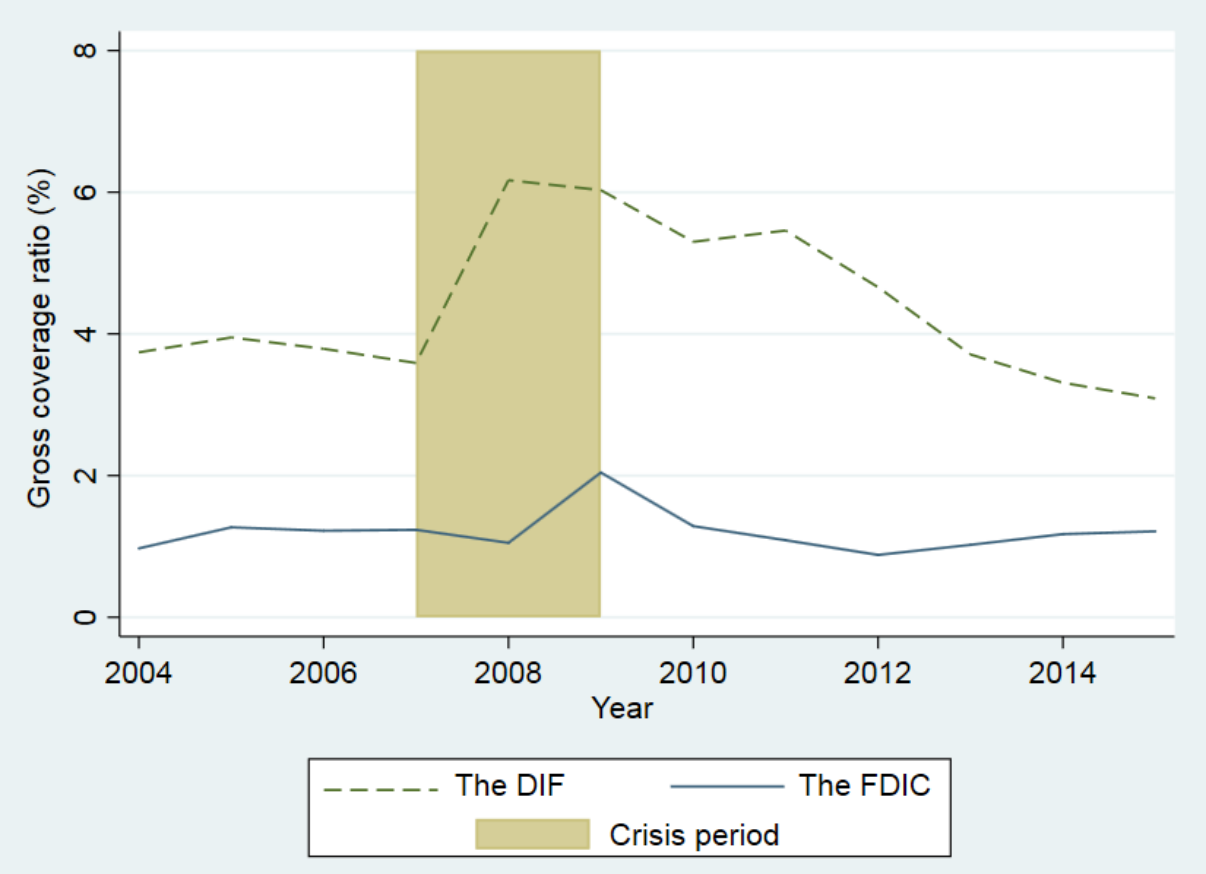
risk-taking, thus undermining the credibility of deposit insurance. Most of the failed deposit insurance funds charge a flat rate assessment, and some of them set an upper limit on the assessment rate. On the contrary, the DIF charges its members based on their risk categories without limit to restrict excessive risk-taking of the member banks.

(vi) Management board consisting of member banks' managements

The board of directors in a successful deposit insurance fund generally consist of the managers of its member banks (Calomiris (1989)). Since members have better access to their peers' information, it lowers monitoring cost. With mutual liabilities among members, it also boosts the monitoring incentives of the board members. Beck (2002) argues that there is a positive effect of member banks' management on peer monitoring in the context of the German private banks' deposit insurance fund. The management board of the DIF primarily consists of presidents and chief executive officers of the DIF-insured banks. Additionally, the small number of DIF members enables a club atmosphere, which encourages mutual monitoring and mutual support, similar arguments are also made by Beck (2002).

Figure A

Gross Coverage ratio of the Depositors Insurance Fund and the Federal Deposit Insurance Corporation



Notes. Figure A compares the gross coverage ratio of the DIF and the FDIC in 2004-2015, the shaded period indicates the crisis period.

Appendix B

To mitigate the concern over membership selection, our baseline results exclude banks which switch membership status during the sample period and non-DIF savings banks that headquartered in Massachusetts. In this section, we show that the results are robust to the inclusion of these two groups of banks.

We replicate the test presented in Table 4 and show the replicated results in Column 1-5 of Table A. The only difference between Table 4 and Table A is that the sample in Column 1-5 of Table A (Table 4) include (exclude) banks that switch DIF membership status within the sample period; and savings banks that are never one of the DIF members in our sample period. Column 1-5 of Table A shows that the results are robust to the inclusion of these groups of banks, the coefficients of interest are still statistically significant and positive in all samples. The magnitude of the estimated coefficients of interest are larger than the respective coefficients of interest in Table 4. Therefore, the exclusion of these groups of banks only underestimates the deposit inflows of DIF member banks during the crisis.

[TABLE A]

Column 6 of Table A include a sample of branches operated by DIF member banks and branches operated by all other savings banks headquartered in Massachusetts, this group of savings banks includes banks that either switch DIF membership status during the sample period or are never one of the DIF members. Since all DIF member banks are savings banks, this group of banks is potentially the most refined control group for our test. However, this group of banks is also the most susceptible to the concern over membership selection, because only savings banks headquartered in Massachusetts are eligible for the DIF membership. Therefore, we choose not to include this group of banks in our main results. The results in Column 6 still soundly support Hypothesis 1. Branches of Massachusetts savings banks that are insured by the DIF receive additional deposit inflows during the crisis, comparing with other branches of Massachusetts savings banks that are only insured by the

FDIC.

This appendix suggest that our baseline results are likely to be the lower bound of the deposit inflows experienced by DIF member banks during the crisis. The exclusion of banks that switch DIF membership status within the sample period; and savings banks that are never DIF members does not overestimate the deposit inflows of DIF member banks during the crisis.

Table A

Baseline result: effect of DIF membership on branch level deposits (including banks which switch membership)

Panel A						
Dependent variable:			**Branch deposits (ln)**			
Sample	Full sample	Full sample	All branches in MA	MA branches operated by MA banks	MA branches of Members and Non-MA banks	MA branches operated by MA savings banks
	(1)	(2)	(3)	(4)	(5)	(6)
Membership*Crisis	0.026***	0.031***	0.093***	0.033***	0.087***	0.222***
	(3.14)	(3.68)	(9.23)	(2.61)	(8.13)	(8.79)
L. Total assets (ln)		0.024***	0.041***	0.057***	0.050***	0.308***
		(6.31)	(6.83)	(3.66)	(8.25)	(5.53)
L. Interest expense ratio (%)		0.066***	0.094***	0.155***	0.072***	0.086***
		(9.22)	(5.84)	(6.76)	(4.24)	(2.69)
L. Charge off ratio (%)		-0.001	0.025***	-0.046***	0.073***	-0.009
		(-0.47)	(2.98)	(-4.51)	(7.57)	(-0.46)
L. Tier 1 capital ratio (%)		-0.020***	-0.005	0.004	0.020***	-0.000
		(-9.27)	(-1.31)	(0.65)	(4.26)	(-0.01)
Branch FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
R-squared	0.190	0.205	0.313	0.278	0.381	0.314
Observations	70,941	70,941	14,763	8,672	10,997	4,277
No. of branches	7,218	7,218	1,553	1,083	1,229	404
SE Cluster	Branch	Branch	Branch	Branch	Branch	Branch
Panel B						
Membership*Crisis	0.041***	0.070***	0.158***	0.089***	0.135***	0.301***
	(3.54)	(6.03)	(11.29)	(4.42)	(9.83)	(8.02)
L. Total assets (ln)		0.024***	0.040***	0.055***	0.051***	0.309***
		(6.29)	(6.70)	(3.54)	(8.35)	(5.54)
L. Interest expense ratio (%)		0.067***	0.100***	0.160***	0.076***	0.085***
		(9.39)	(6.23)	(6.96)	(4.50)	(2.65)
L. Charge off ratio (%)		-0.002	0.007	-0.053***	0.050***	-0.009
		(-0.88)	(0.83)	(-5.37)	(5.36)	(-0.45)
L. Tier 1 capital ratio (%)		-0.020***	-0.004	0.004	0.021***	0.000
		(-9.26)	(-1.11)	(0.64)	(4.44)	(0.02)
Branch FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
R-squared	0.190	0.205	0.314	0.279	0.381	0.315
Observations	70,941	70,941	14,763	8,672	10,997	4,277
No. of branches	7,218	7,218	1,553	1,083	1,229	404
SE Cluster	Branch	Branch	Branch	Branch	Branch	Branch

Notes. Table A presents the results obtained using Eq. 1 where the dependent variable is the logarithm of branch deposits (in $000) and the main explanatory variable is an interaction term between the dummy variable for membership and the dummy variable for crisis (0 otherwise). The sample in Table A includes banks switch DIF membership status during the sample period. In Panel A, the crisis period is defined as Q3:2007-Q2:2010. In Panel B, the crisis period is defined as Q3:2007-Q2:2008. Column 1 includes the full sample including branches of all banks from Massachusetts, New York, New Hampshire, Connecticut, Vermont, Rhode Island. Column 2 includes results for the same sample as in Column 1 with additional 3 years-lagged institution-level control variables. Column 3 includes results obtained using a sample covering branches of all banks operating in Massachusetts. Column 4 includes results obtained using a sample including only Massachusetts branches of banks headquartered in Massachusetts (members and non-members of Depositors Insurance Fund). Column 5 includes results obtained using a sample in Column 3, excluding branches of banks headquartered in Massachusetts which are not members of the Depositors Insurance Fund. Column 6 includes results obtained using a sample including all branches operated by savings banks headquartered in Massachusetts. Definitions of all control variables are shown in the notes of Table 4. Robust *t*-statistics are presented in parentheses. Standard errors are clustered at the branch level. *** p<0.01, ** p<0.05, * p<0.1.