Private deposit insurance, deposit flows, bank lending, and moral hazard

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

JEL Codes: G21, G28

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1. Introduction

We investigate the role of private unlimited deposit insurance as a complement to federal deposit insurance for deposit flows, bank lending, and moral hazard during a financial crisis. Despite the importance of understanding the effects of deposit insurance design features like ownership and management by private parties or the government, and full or partial insurance, evidence on this subject is scarce. Prior work typically relies on cross-country data. This poses econometric challenges because limited variation of design features within countries over time hampers the inclusion of country-fixed effects. Moreover, data for countries with multiple deposit insurance schemes managed by private parties and the government to conduct within-country estimations allowing to rule out country-specific effects are difficult to obtain.[1] Finally, establishing the role of deposit insurance systems during financial turmoil requires not only deposit data, but also a crisis that is unrelated to those banks whose behavior is the subject of study.

To tackle these challenges, this paper exploits a novel setting. A private deposit insurance fund, the Depositors Insurance Fund (MA-DIF), insures deposits above the Federal Deposit Insurance Corporation (FDIC) coverage limit and imposes additional scrutiny on state-chartered savings banks headquartered in Massachusetts. We compare deposit flows, lending, and risk-taking in banks that are members of the MA-DIF with banks located within Massachusetts and the surrounding states whose deposits are only insured by the FDIC.

The effect of private unlimited deposit insurance coverage in addition to a government-run scheme on deposit flows, lending, and moral hazard is an empirical question. Depositors may respond strongly to deposit insurance design features during crises. Incentives to monitor banks and acquire signals about the protection of their claims increase in such periods, reflecting concerns about banks' liquidity, solvency, and

[1] Adema et al. (2019) report that nine countries (Canada, Germany, Italy, Japan, Korea, Mexico, Brazil, the U.S., and Portugal) operate multiple deposit insurance schemes in 2019. Prior work by Beck (2002) provides a detailed description of different deposit insurance schemes in Germany.

doubts about the deposit insurance scheme's credibility (Bonfim and Santos (2017)). In other words, crises act like a "wake-up call" that strengthens market discipline (Martinez-Peria and Schmukler (2001)). It is therefore plausible to expect depositors to take actions to protect themselves. The additional coverage resulting from MA-DIF membership may deter these banks' depositors from withdrawing funds. Further, it may motivate customers of non-members to reallocate funds into member banks, triggering deposit inflows.[2]

However, ownership and management can undermine the credibility of deposit insurance. While government-run schemes can impose taxes to honour a deposit guarantee, private insurance schemes are constrained by their reserves. Consequently, depositors may not put funds into member banks. Depositors may become more risk-averse during crises and split privately insured deposits into multiple non-member banks to remain below the FDIC coverage limit (e.g., Iyer et al. (2019)). If so, deposits of MA-DIF banks may decrease.

Membership in the MA-DIF may also affect the transformation of deposits into loans. Bryant (1980) and Diamond and Dybvig (1983) posit that banks create liquidity by financing illiquid assets with liquid liabilities, highlighting the combination of deposit-taking and lending (Kashyap et al. (2002)). However, Gatev and Strahan (2006) argue that banks only provide liquidity during crises when they are awash with funds. Similarly, Ivashina and Scharfstein (2010) show that lending contracts less in banks with better access to deposits in a crisis. If access to private unlimited deposit insurance isolates banks from deposit withdrawals during crises, it is plausible to expect MA-DIF members to increase lending in comparison to non-member banks.

Alternatively, lending of member banks may remain unaffected or even decrease. While banks hoard liquidity during crises (Acharya and Skeie (2011), Acharya and Merrouche (2013)), such increases

[2] This is in line with Acharya and Mora (2015) who document banks do not experience additional deposit inflows in the initial stage of the financial crisis until the government increased the deposit insurance coverage limit from 100,000 USD to 250,000 USD per depositor.

in liquidity do not necessarily increase lending. Acharya and Mora (2015) show that the mechanism that allows banks to transform deposits into loans collapsed prior to the increase in the FDIC deposit insurance coverage on 3rd October 2008. Moreover, design features of the MA-DIF such as greater scrutiny and peer monitoring suggest member banks are likely to be cautious with their loan origination. Therefore, synergy effects between deposits and lending may be undermined by members' low risk appetite.

Deposit insurance is widely considered to increase moral hazard (Keeley (1990)). It undermines depositors' monitoring incentives and increases bank risk-taking. While this concern is supported by theory (e.g., Chan et al. (1992), Boot et al. (1993)), the empirical evidence is mixed (e.g., Gropp and Vesala (2004), Pennacchi (2006), Lambert et al. (2017), Calomiris and Jaremski (2019)).

Compared with banks whose deposits are only federally insured, the additional coverage of MA-DIF member banks may indeed undermine depositors' monitoring incentives. Member banks of the MA-DIF could therefore be expected to accumulate more risk in the pre-crisis period which will unfold during the crisis. Furthermore, MA-DIF member banks could use the additional deposit inflows to originate risky loans during the crisis.

However, this view ignores one of the important incentive-compatible features of the MA-DIF, the private nature of the MA-DIF. Any costs from paying out deposits of failed member banks will be incurred by other member institutions. This creates incentives for peer-monitoring (e.g., Calomiris (1989, 1990), English (1993), Beck (2002)). Rather than reducing monitoring intensity by depositors, membership in the MA-DIF reallocates monitoring incentives from depositors to member banks. Moreover, monitoring intensity may increase. While depositors tend to be small and unsophisticated, banks possess superior monitoring technologies (King (2008)). Thus, MA-DIF membership shifts monitoring incentives from less to more capable monitors, reinforcing market discipline (Danisewicz et al. (2018, 2021)). It is therefore possible, that MA-DIF banks are more prudent in loan origination than non-member banks, suggesting less risk-taking.

To motivate our analysis, Figure 1 illustrates deposit flows in Massachusetts prior to, during, and after the financial crisis.[3] The graph highlights that MA-DIF member banks (represented by the dashed line) experience deposit inflows during the crisis (shaded area). Other banks (represented by the solid line) experience deposit outflows until 2009. In terms of the volume of deposits, total deposits of MA-DIF member banks increase by 4.4 billion USD over the crisis period. Total deposits of other banks decrease by 30 billion USD during the crisis.

[FIGURE 1]

Our empirical results reinforce the visual evidence. We present novel evidence that deposits of MA-DIF member banks increase relative to non-members during the crisis. This effect is greater prior to the increase in the FDIC deposit insurance coverage limit and prior to the introduction of the Transactions Account Guarantee (TAG) Programme.

Disentangling the effects arising from the unlimited coverage from other features that come with the private nature of the MA-DIF is challenging. These other features focus on additional scrutiny in the form of disclosure requirements of the banks' financial condition to the insurer and peer monitoring. Our research suggests that such design features beyond the coverage limit play some role for deposit inflows. More importantly, these features mitigate moral hazard.

The result that MA-DIF member banks experience greater deposit inflows relative to non-members prior to the increase in the FDIC coverage limit suggests that the unlimited coverage of the MA-DIF matters for deposit inflows. This result is reiterated by the fact that MA-DIF member banks' deposits increase more in comparison to non-member banks that rely more on uninsured deposits. Yet, we still find that MA-DIF membership results in a significant increase in deposits in comparison to banks with lower volumes of FDIC-uninsured deposits at the onset of the crisis. Another test highlights that banks that become members

[3] Note that the number of non-member banks headquartered in Massachusetts is larger than the number of MA-DIF member banks. Figure 1 therefore uses two scales, one for MA-DIF members on the left-hand side, and one for non-members on the right-hand side to provide clearer insights into the evolution of deposits over time.

of the MA-DIF also attract more deposits, even in tranquil periods when coverage is a lesser concern. These two latter results suggest that design features which increase scrutiny via the quarterly review of members' financial condition by the insurer' board, and greater incentives for peer monitoring also matter for the documented increase in deposits.

We also find that MA-DIF member banks lend significantly more than non-members in the crisis. The increase is driven by residential mortgage lending and loans with longer maturities. To confirm that the differences in mortgage lending between MA-DIF members and non-members do not reflect demand conditions, we turn to loan-application-level data obtained via the Home Mortgage Disclosure Act (HMDA) that corroborate our results.

A key contribution of our work is that our analysis rejects the view that unlimited deposit insurance coverage increases moral hazard. The Tier 1 capital ratio, the charge off ratio, Z-Scores, and the ratio of nonperforming mortgages to total mortgages remain unaffected or show limited evidence for improved soundness during the crisis in MA-DIF member banks. Further, we find that MA-DIF member banks originate significantly less risky mortgages, approximated by loan-to-income ratios, than the control group. Our results highlight the importance of features of the MA-DIF that incentivize members' prudent behavior.

Although membership in the MA-DIF is compulsory for state-chartered savings banks in Massachusetts, banks' ability to choose and change their charter, relocate headquarters, or merge with another institution gives rise to potential selection bias. Our main tests therefore only include banks that are consistently members of the MA-DIF between 2004 and 2015. This mitigates concerns that banks acquire membership to benefit from the additional layer of protection. It also ensures that membership during the crisis is not conditional on deposits and lending. Potential differences between MA-DIF members and the control group may also influence our inferences. To alleviate such concerns, we show that the outcome variables we study as well as several measures of balance sheet composition of MA-DIF member banks

evolve similarly to non-member banks' variables prior to the crisis. This suggests that banks in the control group constitute a valid counterfactual.

Our findings are important. Deposits account for more than three quarters of all banks' funding. Over 62 % of deposits in the U.S. banking system were uninsured at the onset of the crisis (Acharya and Mora (2015)). Since uninsured deposits are often impaired in a bank default, they are prone to runs (Egan et al. (2017)).[4] It is therefore crucial to understand the effects of a private deposit insurance scheme that provides full coverage that protects such deposits.

Investigating coexisting private and government-run deposit insurance schemes that offer different levels of coverage to comprehend their effects for the behavior of banks and depositors has attracted attention after the crisis. Debates focus on the establishment of a common deposit protection system, the European Deposit Insurance Scheme, to complete the banking union in the European Union. While this research uses data for Massachusetts, our work offers insights for the conversations in the European Union. In some member states, e.g., Germany, the statutory deposit guarantee scheme is complemented by multiple private schemes that offer more generous protection, thus closely resembling the setting in Massachusetts. Our study informs this debate by highlighting depositors' ability to differentiate between design features of deposit insurance schemes. Our research also illustrates the benefits as well as drawbacks of multiple deposit schemes. While member banks in the privately-run scheme that offers additional protection obtain more deposits, originate more loans, and act more prudently during crises, we document a potentially dark side in the form of greater deposit volatility.

2. Institutional background

The MA-DIF was established by the Massachusetts legislature in 1934 in response to the Great Depression as an industry-sponsored private insurance company to insure deposits in savings banks

[4] Diamond and Dybvig (1983) posit that run-prone uninsured depositors are the main source of bank fragility. Iyer and Puri (2012) show that uninsured depositors are most likely to run. Iyer et al. (2016) show that the composition of depositors plays a role for which depositors run.

chartered in Massachusetts. Membership of the FDIC and the MA-DIF was mutually exclusive until 1956. Since then, the MA-DIF insures deposits above the FDIC insurance coverage limit, resulting in *de facto* complete protection for depositors whose banks are members in the MA-DIF.[5]

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

(i) Insurance coverage

The MA-DIF offers full deposit insurance for its members' deposits and accrued interest without limit. All deposits above the FDIC insurance coverage limit, which rose from 100,000 USD per depositor at the beginning of our sample period to 250,000 USD in Q3:2008 (see Figure 2), in MA-DIF member banks are insured. The MA-DIF protects 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 MA-DIF insurance applies depends only on the membership of banks in the scheme. The location of branches or residence of depositors does not matter.

[FIGURE 2]

(ii) Membership

Membership in the MA-DIF is compulsory for all savings banks chartered in Massachusetts. However, the number of members varies over time due to mergers and acquisitions, changes in charters, and failures. During our sample period 2004-2015, 51 banks are consistently members.

(iii) Funding

The MA-DIF is exclusively funded by its members. There is no support from either the federal or the

[5] In Massachusetts, there are two other private deposit insurance funds, the Share Insurance Fund, and the Massachusetts Credit Union Share Insurance Corporation. The former is exclusively available to co-operative banks and merged after our sample period with the MA-DIF in March 2020. The latter was only available to credit unions. Both funds are not relevant to our study because our sample only includes commercial and savings banks.

state government. Its sources of funds include accumulated annual assessments on its members and interest income from its investments. The board of directors determines the assessments rates based on excess deposits and risk classifications of each member bank. The MA-DIF's assessment schedule is modelled after the risk-assessment matrix developed by the FDIC in the late 1990s. This assessment schedule is based on the composite CAMELS rating from its most recent regulatory examination, and its capital classification. The current assessment rate for a well-capitalized member bank is 2 basis points of excess deposits. The assessment rate must be approved by the Commissioner of Banks of the Commonwealth of Massachusetts.

Massachusetts law and the MA-DIF's investment policy restrict the investments to U.S. Treasury and federal agency obligations and obligations fully guaranteed by the U.S. government.

(iv) Management

Unlike the FDIC which is a federal government agency managed by a board of directors with directors appointed by the president and confirmed by the senate, the MA-DIF is privately managed by its member banks without any government involvement. The board of directors primarily consists of presidents and chief executive officers of member banks. The MA-DIF is examined annually by the Massachusetts Division of Banks. It is audited by an independent auditor.

The MA-DIF quarterly reviews its members' financial reports. Additionally, the MA-DIF consults on a regular basis with both the FDIC and the Massachusetts Division of Banks, sharing information about the financial condition of its members. The MA-DIF has the authority to conduct a special examination of a member bank, with the approval of the Massachusetts Commissioner of Banks. However, this examination authority has rarely been requested in the past. If so, it was only requested in extreme cases. The MA-DIF's role in overseeing its members is largely focused on monitoring members rather than having broad regulatory powers. Unlike the FDIC, the MA-DIF has no role in the resolution process of member banks, and the MA-DIF has no authority to impose enforcement actions against its members.

(v) Public awareness

Member banks display the MA-DIF logo on websites, doors, and teller stations, depositors can access the details of the scheme on the website, brochures, and via customer service representatives.

During the crisis, increasing media attention focuses on the MA-DIF. For example, an article "Massachusetts sets standard on deposits" published by the Wall Street Journal on 5th August 2008 reports that member banks report many inquiries from new and existing clients.

> *"[…] 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 MA-DIF during the crisis. It also illustrates that the MA-DIF attracts depositors during the crisis. The annual report of the MA-DIF also reports increased enquiries from depositors during the crisis in 2008.[6]

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

Our Internet Appendix A contains additional information about depositors' awareness and the MA-DIF. Figure A.1 shows the monthly Google Trends index for the period 2004-2015. The index illustrates that the financial crisis raises depositors' interest in the MA-DIF.

We present a detailed comparison between design features of the FDIC and the MA-DIF in Panel A of Table A.1 of our Internet Appendix. In Panel B, we summarize common characteristics of different insurance mechanisms since the Antebellum period in the U.S. based on White (1981), Calomiris (1989, 1990), and English (1993).

3. Data and Methodology

We obtain annual data for 2004-2015 for branches of commercial and savings banks in the U.S. from the FDIC's Summary of Deposits (SoD) which records deposits as of 30th June each year. We

[6] The article of the Wall Street Journal is available on *https://www.wsj.com/articles/SB121789647048112087*, and the 2008 annual report is available on *https://www.difxs.com/reports/AnnualReports/DIFAnnualReport2008.pdf*.

complement the deposit data with quarterly data for commercial and savings banks from the Call Reports during Q1:2004-Q4:2015, available from the Federal Reserve Bank of Chicago. We choose this time span because information on MA-DIF membership is available from 2004 annually. The sample period includes the crisis period.

To minimize geographic heterogeneity, our sample includes branches in Massachusetts and the five surrounding states: Connecticut, New Hampshire, New York, Rhode Island, and Vermont. 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.

Following Gatev et al. (2009), we use the most recent merger file from the Federal Reserve Bank of Chicago to identify mergers and acquisitions and drop observations during the year of the M&As. We only include branches of MA-DIF member banks and non-member banks that operate at least one year prior to and following the onset of the crisis. Applying these sample screens results in 69,108 observations for 7,006 branches operated by 365 banks in all 6 states.

To eliminate state-specific effects, most tests on the branch-level are based on branches in Massachusetts, resulting in a cleaner sample of 13,189 observations for 1,361 branches operated by 51 MA-DIF member banks and 52 non-member banks.

For the lending tests, we use bank-level data. We focus on banks headquartered in Massachusetts, resulting in a sample of 3,449 observations for 51 MA-DIF member banks and 32 non-member banks, which account for around 2% of total assets of all U.S. commercial and savings banks. We refine the lending results from the Call Reports using annual mortgage-application-level data collected by the Federal Reserve under the HMDA. This dataset records the year of the mortgage application, lender identity, borrower characteristics, loan amount, and the approval result. To be consistent with the bank-level analysis, we focus on the 83 Massachusetts-headquartered banks in the bank-level sample, resulting in a sample of 371,898 mortgage applications.

[TABLE 1]

Panel A of Table 1 presents descriptive statistics for the banks that enter our analyses. We summarize annual branch-level deposits for branches in Massachusetts and all other variables for banks headquartered in Massachusetts. We also report summary statistics for our quarterly bank-level variables.

Banks in the Northeast were subject to restrictive capital requirements in the 1980's and 1990's (FDIC (1997)). They had concentrated on residential real estate lending, and state regulators in the Northeast responded accordingly as a result of increases in non-performing loans. However, there are no regulatory differences between MA-DIF member banks and non-members during our sample period. MA-DIF members are subject to the same statutory regulations as non-member banks.

Next, we verify whether such differences still play a role prior to the crisis and examine whether banks in Massachusetts are representative of the population of U.S. banks. Panel B of Table 1 compares key variables of MA-DIF member banks with other savings banks across the U.S. This test suggests that MA-DIF member banks are similar to savings banks outside Massachusetts before the crisis. The only exception is that MA-DIF member banks have lower average deposit and loan rates.

3.1 Methodology

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

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

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; $Membership_{v,i}$ indicates whether a branch is operated by MA-DIF member banks, it equals one if a bank is a member of the MA-DIF (0 otherwise). Since we require banks to be members of the MA-DIF throughout the sample period 2004-2015, $Membership_{v,i}$ is a time-invariant variable. $Crisis_t$ takes on the value of 1 if the observation is in the crisis period (0 otherwise). $Membership_{v,i} \times Crisis_t$ equals 1 for the observations of branches operated by MA-DIF member banks during the crisis period (0 otherwise). We

define the crisis period as Q3:2007-Q2:2010. Data from the SoD are only available as of 30th June on an annual basis, β_1 is our coefficient of interest.

$X_{i,t}$ is a vector of time-varying control variables, including a set of bank-specific variables. We control for the logarithm of total assets to measure size. To account for pricing effects, we use the ratio of total deposit interest expenses to total deposits to capture average deposit interest rates. Further, we use the charge off ratio to measure risk, and the Tier 1 capital ratio to measure capitalization. We use the ratio of deposits-to-liabilities to measure reliance on deposits. The loans-to-assets ratio and the mortgages-to-assets ratio capture differences in bank activities.

To address concerns that characteristics of depositors differ systematically across branches of member and non-member banks, $X_{i,t}$ includes a set of county-level variables that measure financial literacy, social capital (to approximate trust), and population characteristics that capture age, gender, and the presence of minorities.[7] 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.

On the bank-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 bank-level lending or risk-taking. The coefficient β_1 is the key coefficient of interest. The bank-level data is on a quarterly basis. γ_i represents bank-fixed effects, and γ_t are quarter-fixed effects. We cluster heteroskedasticity-adjusted standard errors

[7] In the absence of specific measures of financial literacy on the county level, we approximate financial literacy by the proportion of individuals with a high school degree or above. We measure social capital using the index developed by Rupasingha et al. (2006). The proportions of individuals with age between 20 and 25 or above 65, of females, and of minorities are used to capture further population differences.

on the bank-level in Equation 2.[8]

In our lending tests, $X_{i,t}$ represents the same vector of control variables as in Equation 1, except for the exclusion of county-level control variables and the interest expense ratio. We replace the interest expense ratio with the ratio of total interest income to total loans. The vector of control variables, $X_{i,t}$, for testing the effect of MA-DIF membership on risk-taking consists of total assets, the deposits-to-assets ratio, and the loans-to-assets ratio. All control variables are lagged by three years to mitigate endogeneity concerns.

3.2 Selection into membership and sample choice

Our variable of interest, $Membership_i \times Crisis_t$, is plausibly exogenous for two reasons. First, to alleviate selection problems, our tests only include banks that are consistently members during the period 2004-2015. This procedure mitigates concerns that banks select into MA-DIF membership by converting the charter to become Massachusetts-chartered savings banks. In our sample, banks acquire membership before the crisis. We exclude banks that join the MA-DIF during the sample period. Therefore, the membership of banks during the crisis is not conditional on deposits and lending in our analysis.[9]

Second, a driving force behind the crisis was a credit boom which fuelled a housing bubble. Potentially, lending of MA-DIF member banks could contribute to the build-up of the crisis. However, Acharya and Richardson (2009) suggest that the crisis is primarily driven by a shift of banks' business models towards securitization adopted by large, complex financial institutions. MA-DIF member banks are local savings banks. None of them has assets over 50 billion USD during the sample period. These banks, at best, played a limited role in triggering the financial crisis. Therefore, $Crisis_t$ is plausibly exogenous to

[8] Iyer et al. (2016) show heterogenous depositor responses to solvency risk, and Iyer and Puri (2012) show that depositors' social networks mitigate bank runs. One of the limitations of our study is the lack of depositor-level data to control for the role of depositors' characteristics.

[9] In Internet Appendix B, Table B.1, we show that our result is robust to the inclusion of Massachusetts savings banks that become MA-DIF members during the sample period. The results in the sample of Column (1)-(3) also suggest that non-member banks switching to become member banks receive additional deposits, even in non-crisis periods.

their deposits and lending. Likewise, the "too-big-to-fail" explanation could hardly be invoked to explain deposit inflows to member banks.

3.3 Do non-member banks constitute a valid counterfactual?

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

This section shows that non-members are a valid counterfactual. Most of our tests are based on branches in Massachusetts and banks headquartered in Massachusetts. Panel A and B in Table 2 examine differences in the annual growth rate of branch-level deposits and in the quarterly growth rate of other dependent variables between MA-DIF member banks and non-member banks during the pre-crisis period. The null of the equality of means cannot be rejected in any cell, suggesting non-members plausibly constitute a valid counterfactual.

To highlight that our results are not driven by the evolution of balance sheet composition prior to the crisis, we also compare the growth rates of the deposits-to-liabilities ratio, the mortgages-to-assets ratio, the loans-to-assets ratio, and the Tier 1 capital ratio between MA-DIF member banks and non-member banks. The results in Panel C suggest that the portfolio compositions of MA-DIF member banks and non-member banks evolve in similar fashion before the crisis.

[TABLE 2]

4. Results: Private deposit insurance and deposit flows

We now examine the effect of membership in the MA-DIF on deposit flows during the crisis. Further tests focus on alternative explanations.

4.1 Effect of the MA-DIF on deposits on the branch-level

Table 3 presents the results for deposit flows on the branch-level. 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. The estimates for our coefficient of interest, β_1, are significant and positive. Column (1) only includes the interaction term between the dummy identifying MA-DIF member banks and the dummy for the crisis without any control variables. There is a significant increase in deposits of 1.8 % (*t*-statistic of 2.01) for member banks during the crisis. Column (2) includes control variables and confirms the significant deposit increase for member banks.

We expect the differential evolution of deposit flows to be more pronounced when we only consider branches of member and non-member banks located in Massachusetts. Depositors incur lower cost to transfer deposits within Massachusetts in terms of transportation, monitoring, and information cost.

Column (3) shows the results for the sample including all branches in Massachusetts, regardless of their headquarters' location. Deposits of members increase by 7.7% (*t*-statistic of 6.58). Compared with the results in Column (1) and (2), the magnitude of the increase in deposits is greater.

Column (4) only includes branches located in Massachusetts of banks headquartered in Massachusetts, while the control group in Column (5) only includes Massachusetts branches operated by non-member banks headquartered outside Massachusetts. Since depositors incur lower information cost and monitoring cost for banks headquartered in their state of residence, we expect the coefficient of interest to be lower when we only include Massachusetts branches operated by Massachusetts banks in the sample. Consistent with this expectation, size and significance of the estimated β_1 in Column (4), which suggests that deposits of members increase by 3.8 % (*t*-statistic of 2.41), are lower compared with Column (5), which shows that deposits of members increase by 8.2 % (*t*-statistic of 6.85).

To alleviate concerns about systematic differences in the treatment and control group, we show an additional test using a matched sample, following Lemmon and Roberts (2010). We use nearest neighbor matching with replacement based on branch locations (counties), pre-crisis averages of the growth rate of total deposits, average interest rates on deposits, total assets, the charge off ratio, and the Tier 1 capital ratio.

We then replicate the estimation with the matched sample in Column (6). The coefficient and the *t*-statistic using the matching strategy remain similar in comparison to the ones in the unmatched sample in Column (2). Our findings do not seem to be driven by differences between MA-DIF member banks and non-member banks in terms of branch location, size, soundness, and deposit rates.

[TABLE 3]

Panel B adopts a narrower definition of the crisis period, classifying the crisis to occur from Q3:2007 to Q2:2008. We expect deposit growth of member banks to be higher 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 introduction of the Transaction Account Guarantee Program (TAGP) on 14th October 2008. We expect the estimates for our coefficient of interest, β_1, to be larger in Panel B.

The behavior of the key coefficient in terms of magnitude and significance across Panel A and B highlights two issues. First, it shows that the additional coverage offered by the MA-DIF is associated with deposit inflows during the crisis. Second, the fact that deposit inflows are still increasing even after raising the FDIC insurance coverage limit, suggests that other features inherent in the nature of the MA-DIF also matter for the inflows of deposits.

The results in all columns of Panel B support this view. The estimates for β_1 increase in magnitude. The significance level of the coefficient in Panel B of Column (4) (*t*-statistic of 3.76) is also greater than in Column (4) of Panel A. This is strong evidence that MA-DIF membership is associated with deposit inflows during the crisis. Our results are robust to the definition of the crisis period. Moreover, tests using branch-level market shares and branch-level deposits scaled by total assets also support our inferences (see Internet Appendix Table C.1). Deposit inflows are more significant prior to the expansion of the government guarantees.

Next, we explore which types of deposits are most affected by membership in the MA-DIF. We expect that depositors of FDIC-uninsured deposits have greater incentives to seek the additional layer of

protection of the MA-DIF during a crisis. If our conjecture is true, the increase in deposits of MA-DIF banks should be stronger, compared with non-member banks with higher levels of uninsured deposits, and *vice versa* when we compare MA-DIF members with non-members with lower uninsured deposits.

To test this idea, we include in Column (7) of Table 3 Massachusetts branches operated by non-member banks where the volume of uninsured deposits is below or equal to the median of non-member banks. Column (8) includes branches in Massachusetts of non-member banks where the volume of uninsured deposits is above the median as the control group.

The results support our predictions. The coefficients for β_1 in Panel A and B in Column (8) are significantly larger, compared with Column (7). In both panels, the tests following Paternoster et al. (1998) reject the equality of the coefficient of interest between the two samples.[10]

4.2 Evolution of deposit flows over time

We next trace out the dynamic effect of MA-DIF membership on deposits throughout the sample period by including a series of year dummy variables in the baseline regression.

$$Deposit_{v,i,t} = \beta_0 + \beta_1 Membership_{v,i} \times 2004_t + \beta_2 Membership_{v,i} \times 2005_t + \cdots + \beta_{10} Membership_{v,i} \times 2013_t + \beta_{11} Membership_{v,i} \times 2014_t + \delta X_{i,t} + \gamma_v + \gamma_t + \epsilon_{v,i,t} \quad (3)$$

where the respective year dummy variable (2004_t- 2014_t) =1 if the observation is in the respective year, 0 otherwise. Definitions of other variables follow Equation 1. Figure 3 plots the estimated coefficients and the 95% confidence intervals of our coefficients of interest, (β_1 -β_{11}), adjusted for branch-level clustering.

[10] In unreported tests on the bank level, we show that deposits also increase. This increase is driven by interest-bearing deposits not fully insured by the government. In contrast, non-interest-bearing deposits protected by the TAGP are not significantly affected by membership in the MA-DIF. Similarly, using bank-level data allows to documenting increases in the volume of FDIC-uninsured deposits of members during the crisis. However, there is no increase in FDIC-insured deposits of member banks. Likewise, we find increases in the number of FDIC-uninsured accounts of MA-DIF member banks during the crisis, but not in the number of FDIC-insured accounts.

Figure 3 illustrates that MA-DIF member banks do not receive additional deposits before the crisis, providing additional evidence in support of the parallel trends assumption. Starting in 2007, the effect of MA-DIF membership on deposits becomes positive and significant at the 5% level. The positive effect gradually diminishes until 2010 and becomes statistically insignificant in 2011-2012. The pattern shown in Figure 3 is consistent with our expectation that depositors respond most strongly to the presence of the MA-DIF in Massachusetts at the onset of the crisis.

[FIGURE 3]

4.3 Ruling out alternative explanations

To establish a causal effect arising from MA-DIF membership on deposit flows, we need to rule out alternative explanations.

4.3.1 Deposit interest rates

The first potential alternative mechanism driving our results may be a pricing channel. Members may offer higher interest rates than others. To address this, we split the control group according to the pre-crisis value of the average interest expense ratio in Column (1) and (2) of Table 4. Our tests reject the view that deposit inflows into members are driven by higher deposit interest rates. There is still an increase in deposits of member banks, even compared with non-members paying higher deposit interest rates.[11]

4.3.2 Bank soundness

A further plausible explanation may be that members are considered safer than other banks. Our next set of tests splits the control group by the pre-crisis average values of the return on equity (ROE), the charge-off ratio, and the Z-score to examine the role of soundness. Although one may expect that soundness plays a role for the magnitude of deposit flows, the positive effect of MA-DIF membership on deposit

[11] In Internet Appendix C, Table C.2, we investigate whether average deposit interest rates, proxied by the interest expense ratio, are affected by membership in the MA-DIF during the crisis. This is not the case. Table C.3 shows that MA-DIF member banks which pay higher interest rate receive additional deposits. Figure C.1 shows additional evidence that average deposit interest rates of MA-DIF member banks and other banks move in tandem during the crisis. The magnitude of the difference is economically small (around 2-5 basis points). Therefore, the additional deposit inflows of MA-DIF member banks cannot be explained by relative increases of deposit interest rates of MA-DIF member banks during the crisis.

inflows should be robust to splitting the control group by measures of soundness.

The results in Column (3) to (8) of Table 4 show no evidence that deposit inflows into members are exclusively due to concerns about soundness. Even when we compare the treatment group with non-member banks with higher ROE, lower charge off ratios, and higher Z-scores, deposits of member banks, relative to the respective control group, significantly increase during the crisis.[12]

[TABLE 4]

4.4 Falsification tests and further robustness issues

We now present falsification tests and additional robustness tests. The tables are relegated to our Internet Appendix C.

First, we use Equation 1 but exclude MA-DIF member banks to test if randomly assigning non-member banks a placebo membership in the MA-DIF triggers effects for deposit flows. We do so by setting the variable "Membership" equal to 1 for placebo members (0 for non-members).

We run Monte Carlo simulations, i.e., we estimate the regression and save the *t*-statistic on the coefficient of interest and repeat it 1,000 times to compute rejection rates of the null hypothesis =0 at the 1%, 5%, and 10% levels. We also report the mean coefficient and the average *t*-statistic for the estimated β_1. Because we know that the placebo membership should play no role, the null of zero effect on deposit flows is true. We should only reject the null by making Type I errors.

The rejection rates in Panel A of Table C.4 in Internet Appendix C are low. The average value of the coefficient on the interaction terms is 0. The effect on deposit flows only arises in banks that are members of the MA-DIF while no such effect is observable in banks with a placebo membership.

MA-DIF banks are state-charted savings banks. An alternative explanation for our findings could

[12] Unreported tests confirm that our key inferences are robust to considering participation in the Capital Purchase Programme of the Troubled Asset Relief Program, and the role of regulatory enforcement actions. Bank opacity also plays no role for our inferences.

therefore be that depositors prefer state-chartered savings banks during the crisis, irrespective of being privately insured or not. The next falsification test examines whether state-chartered savings banks in the neighbouring states of Massachusetts experience the same effect as MA-DIF banks. Panel B in Table C.4 replicates our tests from Panel A in Table 3 with separate samples of branches in Connecticut (CT), New Hampshire (NH), New York (NY), Rhode Island (RI), and Vermont (VT), respectively. We exclude branches of MA-DIF banks operating in these states. The key coefficient is the interaction of the dummy variable indicating a state-chartered savings bank and the dummy for the crisis period, Q3:2007-Q2:2010.

This test rejects the alternative explanation. The key coefficient in Column (1) to (5) remains insignificant. State-charted savings banks in the other five states do not experience the same effect as MA-DIF banks. Consistent with these findings, the pattern in Figure 1 above cannot be observed in Figure C.2 of our Internet Appendix C. Total deposits of state-chartered savings banks in the five states surrounding Massachusetts during the crisis do not increase.

We perform further robustness tests that focus on econometric issues. To ensure that our findings do not reflect our choice of fixed effects, and the methods of adjusting standard errors, Table C.5 in the Internet Appendix C shows estimations with a pooled specification (Column 1), replacing branch-fixed effects with bank-fixed effects (Column 2), and including county×year fixed effects (Column 3), clustering standard errors on the bank level (Column 4), and bootstrapping standard errors based on 600 bootstrap simulations (Column 5). The findings remain similar to our baseline estimates.

5. Results: The effect of the MA-DIF on bank lending and moral hazard

Our tests so far examine deposit inflows. A natural question that arises is how do these inflows affect bank lending and moral hazard?

5.1 MA-DIF membership and total lending, maturity structure, and loan categories

We first examine the effect on total loans. Column (1) in Panel A of Table 5 shows regressions with the logarithm of total loans as the dependent variable. Our estimates show that MA-DIF member banks

originate 7.0 % (*t-statistic* 2.36) more loans during the crisis compared to non-MA-DIF banks. This is consistent with observations by Ivashina and Scharfstein (2010). They find that banks funded by more deposits reduce lending less during the crisis than institutions relying less on deposit funding. Column (2) and (3) in Panel A present a breakdown of loans by maturity structure. It is plausible that MA-DIF members preserve liquidity through lending only at shorter maturities, suggesting that they lend less than non-member banks. Alternatively, members may originate loans with longer maturities since membership minimizes the possibility of deposit runs. This 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 increases long-term investment.

[TABLE 5]

We separate total loans into loans with maturity below 5 years, and between 5-15 years. There are no significant effects on loans with a maturity of less than 5 years in Column (2). However, MA-DIF members significantly increase longer-term loans by 32.1 % (*t*-statistic 2.92) relative to non-members (Column 3).

Panel B of Table 5 investigates residential mortgages, construction loans, commercial and industrial loans, and individual loans. These lending categories jointly account for 86 % of total lending in our sample. Column (1) in Panel B shows that MA-DIF member banks increase residential mortgage lending by 5.9 % (*t*-statistic 2.18) during the crisis. There is no evidence that MA-DIF members increase other types of loans.

5.2 MA-DIF membership and mortgage origination

We further investigate the role of MA-DIF membership for mortgage origination using loan-application-level data collected under the HMDA. Loan-application-level data of HMDA record the year of the loan application, lender identity, borrower characteristics, loan amount, and the approval result. Using this data allows controlling for demand for these loans and applicants' credit risk. We also control for

demographic characteristics of loan applicants, including sex and ethnicity. We further control for economic conditions of property location through year-varying county-fixed effects. We combine the HMDA data with bank-level data to control for size, the Tier 1 capital ratio, the charge off ratio, the deposits-to-liabilities ratio, the loans-to-assets ratio, and the mortgages-to-assets ratio.

We report different specifications. Each specification is estimated for a sample of all mortgages, and a sample that excludes mortgages for refinancing. These mortgages are more likely to be securitized (Gilje et al. (2016)). The decline in the origination rate of mortgages for non-members may be due to their greater exposure to the market for securitized mortgages and reflect the collapse of securitization during the crisis. Excluding refinancing originations mitigates concerns that an alternative explanation is at play.

[TABLE 6]

The results in Panel A of Column (1) in Table 6, estimated with a linear probability model, show that mortgage applications to MA-DIF member banks are more likely to be approved during the crisis. Our findings are also robust to the exclusion of refinancing mortgages, shown in Column (2) of Panel A. The coefficient of interest is significantly larger after we exclude refinancing mortgages. Column (3) of Panel A shows that MA-DIF membership does not affect refinancing mortgages.

To further eliminate the role of securitization in our analyses, Panel B of Table 6 uses bank-level data to show that MA-DIF member banks neither increase nor decrease the volume of securitized residential mortgages. The proportion of securitized residential mortgages to total residential mortgages during the crisis period also remains unaffected by MA-DIF membership.

5.3 MA-DIF membership and moral hazard

Prior work (e.g., Keeley (1990), Demirgüc-Kunt and Detragiache (2002)) argues that deposit insurance increases moral hazard. Section 5.2 documents that MA-DIF members do not securitize more mortgages. This suggests that these banks are unlikely to originate more risky loans. We now further investigate the effect of membership in the MA-DIF on risk-taking.

First, we look at changes in three soundness measures: the Tier 1 capital ratio, the charge off ratio, and the Z-Score. Column (1) to (3) of Table 7 illustrate that membership in the MA-DIF does not increase risk-taking. If anything, constraining the crisis period to Q3:2007-Q2:2008 in Panel B shows that the Tier 1 capital ratio is significantly higher for MA-DIF member banks than for the control group. This finding offers some evidence that membership is associated with greater soundness. All regressions include the lags of total assets, the deposits-to-assets ratio, the loans-to-assets ratio, and bank- and year-fixed effects.

[TABLE 7]

Second, we replace our dependent variable with the ratio of nonperforming mortgages measured at *t+4*, *t+8*, and *t+12* quarters to total mortgages at t_0. These tests, shown in Column (4) to (6) of Table 7, do not suggest any increase in risk-taking.

Third, we examine changes in the loan-to-income ratio, our final proxy for borrower risk (e.g., Dagher and Sun (2016)). We present results for all mortgages and also separately for retained and sold mortgages. All tests control for bank and loan characteristics, include bank-fixed effects, and an interaction of county-fixed effects with year-fixed effects.

Column (1) of Table 8 highlights that, following an increase in deposits during the crisis period, MA-DIF member banks originate loans with significantly lower loan-to-income ratios than non-members. The key coefficient suggests a 5.9 % reduction in the loan-to-income ratio (*t*-statistic -6.93). MA-DIF institutions are more conservative when we focus on retained mortgages in Column (2). The loan-to-income ratio of retained mortgages in member banks declines by 14.5 % (*t*-statistic -10.01) relative to the control group. Column (3) shows that MA-DIF member banks reduce the loan-to-income ratio by 1.3 % (*t*-statistic -1.43) compared to non-member institutions in the subsample for mortgages that are subsequently sold.

Our results challenge the dominant view in the literature that generous deposit insurance coverage increases moral hazard. In contrast, these findings illustrate that unlimited deposit insurance – when embedded in a private scheme that imposes additional scrutiny on its members via peer monitoring and

additional disclosure requirements - can incentivize members to be more prudent in the loan origination process in a crisis.

[TABLE 8]

6. Conclusion

We use the recent financial crisis to study the role of private unlimited deposit insurance for deposit flows, bank lending, and moral hazard. We exploit a hitherto undocumented setting, the existence of a privately-run deposit insurance scheme that protects deposits above the FDIC insurance coverage limit in state-chartered savings banks in Massachusetts. The unique characteristics of our setup allow exploiting within-state variation (and variation across neighbouring states) over time to compare the evolution of deposit flows, lending, and risk-taking between banks that are members of the private unlimited insurance scheme, and banks whose deposits are only protected by the FDIC.

We find that depositors perceive the private unlimited insurance scheme as a credible additional layer of protection during the crisis. This allows member banks to enjoy more stable deposit funding.

We also show that member banks increase lending during the crisis relative to non-members. This finding is driven by residential mortgage lending and lending at longer maturities, suggesting that the availability of stable funding sources allows banks to commit to funding long term projects. Unlike previous papers that focus on government-backed deposit insurance, our final set of results documents that membership in the private unlimited deposit insurance fund does not increase moral hazard during the recent crisis. We find some limited evidence that measures of bank soundness such as the Tier 1 capital ratio tend to improve during the crisis. More importantly, we show that loan underwriting standards, approximated by loan-to-income ratios, tighten significantly during the crisis in member banks.

To conclude, this research is timely and important. First, this work illuminates the current debate in the European Union, where policy initiatives are under way to establish the third pillar of the Banking Union,

the European Deposit Insurance Scheme, where in some member countries multiple deposit insurance schemes already exist that provide different levels of coverage. Our results suggest that depositors exploit such differences in insurance coverage. This carries the risk that banks and countries with lower deposit insurance coverage experience deposit outflows during crises. Therefore, harmonizing deposit insurance schemes under a European Deposit Insurance Scheme has potential to mitigate potentially destabilizing deposit outflows. Second, our findings also suggest that banks that have better access to deposits are less vulnerable to short-term funding shocks which mitigates adverse effects on their lending activities. These results highlight the synergies between deposits and lending. Third, our results show that generous deposit insurance coverage does not necessarily increase moral hazard in a crisis.

Our work illustrates possible benefits of private unlimited deposit insurance during crises. Our findings also provide valuable insights into design features of an insurance scheme that assigns a key role to private parties. However, we emphasize that these findings do not suggest that private unlimited deposit insurance can replace government-sponsored deposit insurance. 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.

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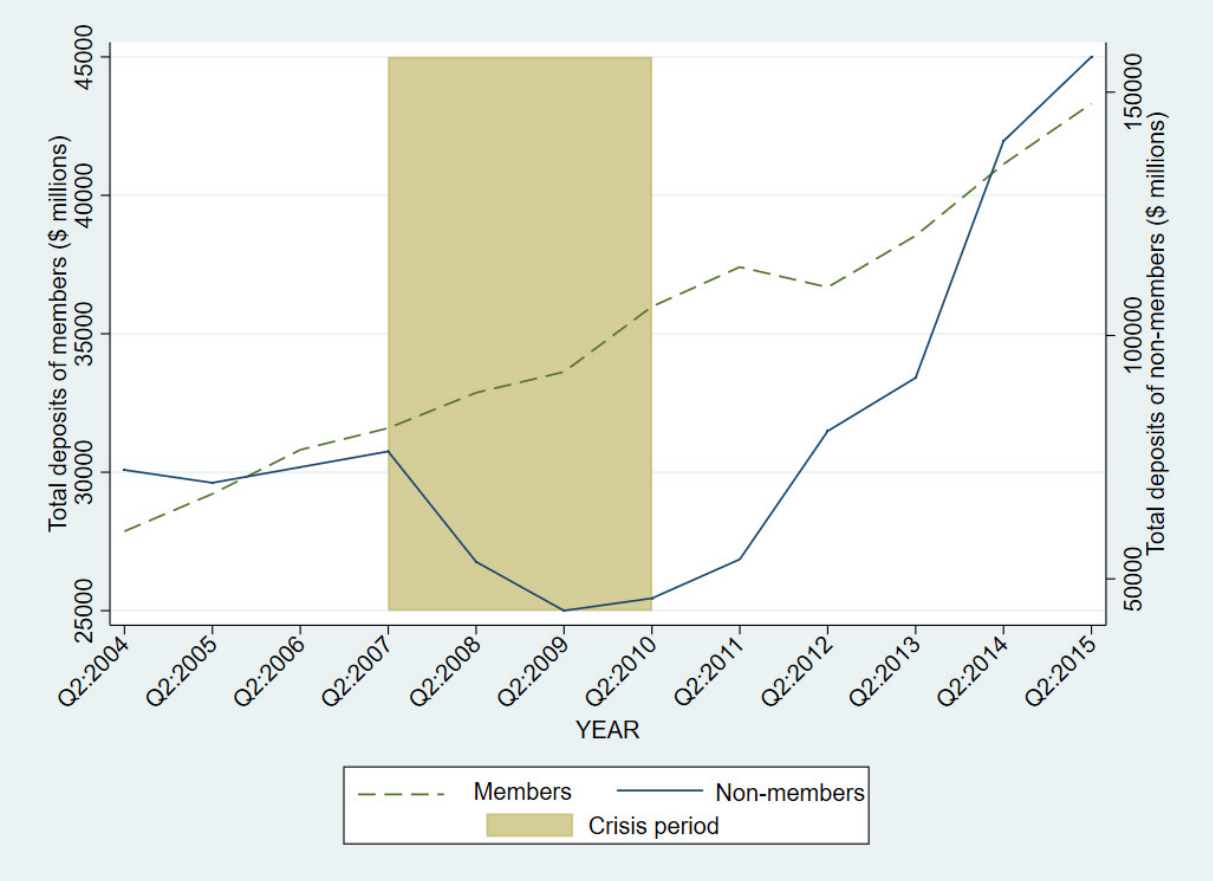
Tables and figures

Figure 1

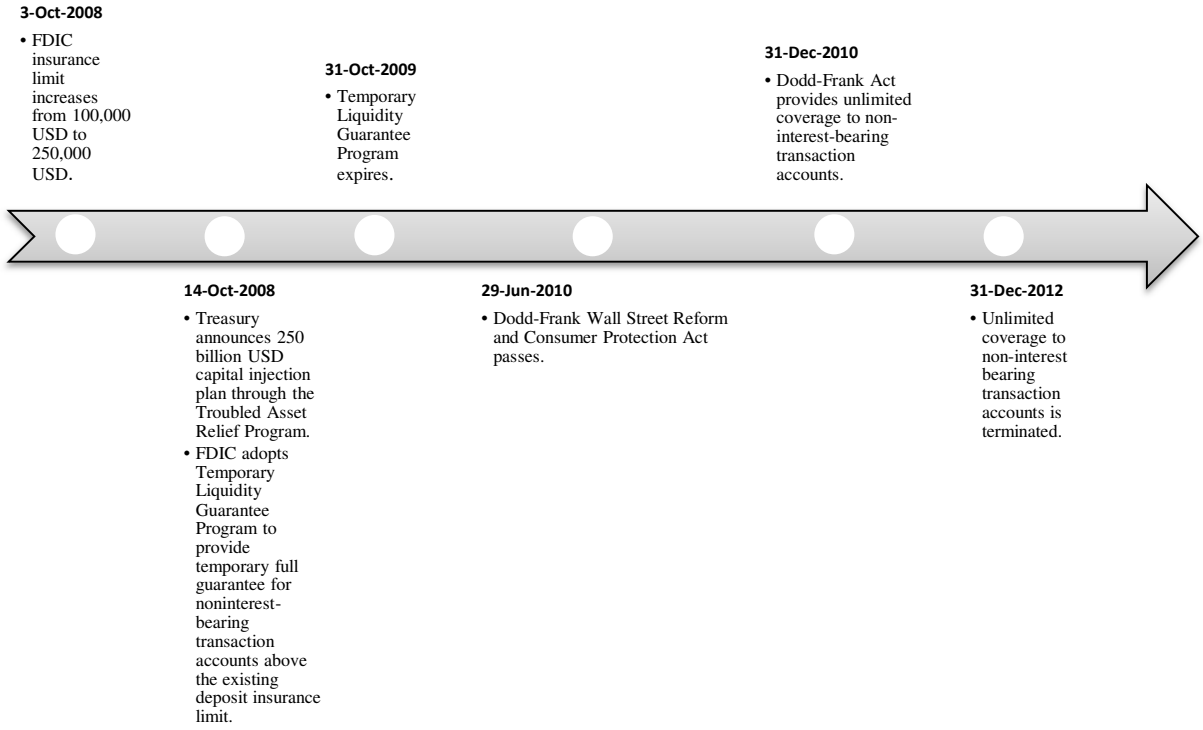
Total deposits of member banks of the Depositors Insurance Fund and of non-member banks headquartered in Massachusetts (2004-2015)



Notes. This figure presents total deposits of MA-DIF member banks (dashed line) and non-member banks headquartered in Massachusetts (solid line). The shaded area indicates the crisis period (Q3:2007-Q2:2010). The figure uses two scales, one for MA-DIF member banks on the left and one for non-members on the right to provide better insights into the evolution of deposits. Total deposits are scaled by 1,000,000.

Figure 2

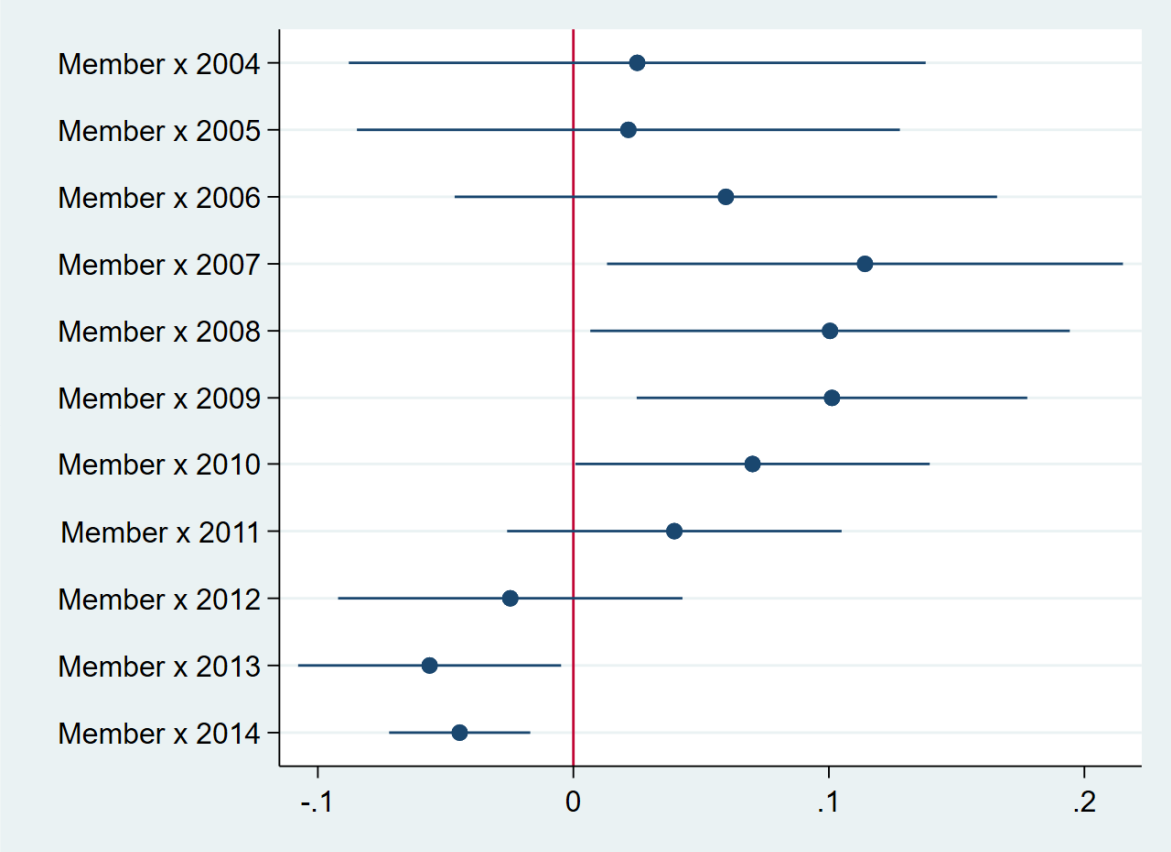
Timeline of government responses to the crisis



Notes. This figure presents the timeline of selected government measures implemented to minimise the negative effect of the crisis in the U.S.

Figure 3

Dynamic impact of MA-DIF membership on deposits



Notes. The figure plots the dynamic impact of MA-DIF membership on deposits throughout the sample period. The solid lines represent 95% confidence intervals, and the dots represent the estimated key coefficients from Equation 3.

Table 1

Descriptive statistics

Panel A					
Summary statistics for banks in Massachusetts					
Branch-level dependent variable:	N	mean	sd	p5	p95
Branch-level deposits	13,189	144,268	1,801,583	10,141	212,853
Bank-level dependent variables:					
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 and land development 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
Deposits-to-liabilities ratio (%)	3,449	87.756	9.550	69.801	99.137
Loans-to-assets ratio (%)	3,449	66.932	12.312	43.309	83.351
Mortgages-to-assets ratio (%)	3,449	40.364	13.902	14.063	60.368

Panel B			
Comparisons between MA-DIF member banks and other savings banks in the U.S.			
Dependent variables	Non-member	Member	Difference
Total loans	529,176	436,820	92,356
Loans with maturity between 5 years and 15 years	76,595	54,894	21,701
Loans with maturity below 5 years	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 (ln)	4.078	4.201	-0.123
Tier 1 capital ratio (%)	12.081	10.758	1.323
Charge off ratio (%)	0.030	0.012	0.018
Interest expense ratio (%) - deposits	0.896	0.809	0.087***
Interest income ratio (%) - total loans	1.699	1.560	0.138***
Deposits-to-liabilities ratio (%)	87.910	86.271	1.640
Loans-to-assets ratio (%)	66.624	66.784	-0.160
Mortgages-to-assets ratio (%)	42.949	44.919	-1.970

Notes. We present summary statistics of branch-level deposits using a sample covering branches operating in Massachusetts between 2004-2015 and summary statistics for bank-level variables using a sample covering banks headquartered in Massachusetts between 2004-2015 in Panel A. Panel B compares the mean values of different variables of MA-DIF member banks and other savings banks in the U.S. in Q2:2007. All numbers are expressed in thousand U.S. dollars, except for the Z-score, the interest expense ratio, the interest income ratio, the charge off ratio, the Tier 1 capital ratio, the deposits-to-liability ratio, the loans-to-assets ratio, and the mortgages-to-assets ratio. All variables are winsorized at the 1 % level and 99 % level. *** p<0.01, ** p<0.05, * p<0.1.

Table 2

Differences in growth rates of dependent variables between MA-DIF member banks and non-member banks

Panel A				
Differences in annual growth rates of branch-level deposits between branches of MA-DIF member banks and non-member 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)
Panel B				
Differences in quarterly growth rates of bank-level dependent variables between MA-DIF member banks and non-member banks				
Time	Q3:06	Q4:06	Q1:07	Q2:07
Variables	Difference	Difference	Difference	Difference
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)
Panel C				
Differences in evolution of balance sheet items between MA-DIF member banks and non-member banks				
Δ Deposits-to-liabilities ratio (%)	-0.008	-0.001	-0.002	-0.004
	(-1.05)	(-0.12)	(-0.25)	(-0.87)
Δ Mortgages-to-assets ratio (%)	-0.002	-0.252	-0.123	-0.009
	(-0.15)	(-0.69)	(-0.87)	(-0.47)
Δ Loans-to-assets ratio (%)	-0.002	-0.372	-0.071	-0.022
	(-0.23)	(-0.45)	(-0.78)	(-0.95)
Δ Tier 1 capital ratio (%)	0.018	0.002	0.004	-0.009
	(1.31)	(0.24)	(0.38)	(-0.67)
Δ Debt-to-equity ratio (%)	0.011	0.006	0.018	-0.015
	(0.68)	(0.52)	(0.90)	(-1.50)
Δ Excess reserve-to-assets ratio (%)	0.015	-0.018	0.059	0.055
	(0.13)	(-0.17)	(0.44)	(0.45)

Notes. In Panel A, we present the difference in annual growth rates of branch-level deposits between Massachusetts branches of MA-DIF member banks and non-member banks. In Panel B, we present the difference in the quarterly growth rates of various dependent variables between MA-DIF banks and non-MA-DIF banks headquartered in Massachusetts over different pre-crisis periods. In Panel C, we present the difference in the quarterly growth rate of various balance sheet items between MA-DIF banks and non-MA-DIF banks headquartered in Massachusetts over different pre-crisis periods. The associated *t*-statistics are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3

Effect of MA-DIF membership on branch-level deposits

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
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	Matched sample	MA branches operated by MA banks	
Control group split							Uninsured deposits	
Percentile							≤ P50	> P50
Panel A								
Effect of MA-DIF membership on branch-level deposits (Crisis definition Q3:2007-Q2:2010)								
Membership*Crisis	0.018**	0.018**	0.074***	0.037**	0.079***	0.048***	0.027	0.083***
	(2.01)	(2.04)	(6.58)	(2.41)	(6.85)	(4.75)	(1.44)	(7.45)
L3. Total assets (ln)		0.029***	0.042***	0.138***	0.044***	0.024***	0.232***	0.036***
		(6.80)	(6.17)	(5.24)	(7.05)	(3.79)	(5.84)	(5.87)
L3. Interest expense ratio (%)		0.073***	0.065***	0.143***	0.052***	0.020	0.145***	0.039**
		(10.05)	(3.93)	(5.49)	(2.95)	(1.30)	(4.65)	(2.55)
L3. Charge off ratio (%)		0.005*	0.033***	-0.037**	0.073***	0.036***	-0.019	0.035***
		(1.70)	(3.67)	(-2.14)	(6.72)	(4.61)	(-1.04)	(3.80)
L3. Tier 1 capital ratio (%)		-0.022***	-0.023***	0.004	0.005	-0.038***	0.006	-0.025***
		(-9.06)	(-5.30)	(0.59)	(0.78)	(-8.60)	(0.74)	(-5.79)
L3. Deposits-to-liabilities ratio (%)		0.001**	0.006***	0.006***	0.003***	0.008***	0.006***	0.006***
		(2.36)	(8.02)	(3.77)	(3.94)	(11.07)	(2.64)	(8.92)
L3. Loans-to-assets ratio (%)		-0.002***	0.002	0.005***	-0.000	0.001*	0.006***	0.000
		(-5.20)	(1.53)	(2.96)	(-0.07)	(1.72)	(2.61)	(0.29)
L3. Mortgages-to-assets ratio (%)		0.003***	-0.004***	-0.005***	-0.001	-0.002*	-0.006***	-0.004***
		(7.09)	(-3.09)	(-3.23)	(-0.70)	(-1.95)	(-3.12)	(-2.72)
Population of 20-25 and above 65 (%)		0.001	0.000	0.012	-0.005	-0.004	0.016	0.002
		(0.25)	(0.06)	(1.11)	(-0.89)	(-0.77)	(1.35)	(0.33)
High school or above (%)		0.005**	-0.005	-0.013	-0.009	-0.015***	-0.021**	-0.004
		(2.31)	(-0.82)	(-1.50)	(-1.27)	(-3.15)	(-2.05)	(-0.60)
Female population (%)		0.020***	0.006	0.048	0.007	0.033*	0.067*	-0.004
		(2.99)	(0.27)	(1.45)	(0.26)	(1.65)	(1.77)	(-0.16)
Minority population (%)		0.000	0.010**	-0.011*	0.009**	0.006	-0.011	0.010**
		(0.37)	(2.42)	(-1.75)	(2.18)	(1.46)	(-1.58)	(2.37)
Social capital index		-0.070***	-0.014	-0.018	0.060	-0.116**	-0.005	-0.017
		(-4.58)	(-0.24)	(-0.13)	(0.97)	(-2.34)	(-0.04)	(-0.32)
Branch FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Adjusted *R*-squared	0.192	0.211	0.354	0.336	0.404	0.317	0.349	0.358
Observations	69,108	69,108	13,189	7,098	10,369	13,584	5,429	12,038
No. of branches	7,006	7,006	1,361	888	1,149	1,214	516	1,254
SE Cluster	Branch	Branch	Branch	Branch	Branch	Branch	Branch	Branch
Test of difference in coefficient *p*-value (two-tailed)	N/A	N/A	N/A	N/A	N/A	N/A	0.010	
Panel B								
Effect of MA-DIF membership on branch-level deposits (Crisis definition Q3:2007-Q2:2008)								
Membership*Crisis	0.034***	0.061***	0.129***	0.083***	0.113***	0.074***	0.078***	0.132***
	(2.78)	(4.94)	(8.91)	(3.76)	(8.11)	(5.99)	(3.03)	(9.65)
L3. Total assets (ln)		0.029***	0.044***	0.137***	0.048***	0.024***	0.230***	0.038***
		(6.78)	(6.40)	(5.20)	(7.61)	(3.87)	(5.82)	(6.22)
L3. Interest expense ratio (%)		0.074***	0.068***	0.145***	0.057***	0.022	0.146***	0.043***
		(10.17)	(4.10)	(5.55)	(3.19)	(1.44)	(4.68)	(2.81)
L3. Charge off ratio (%)		0.004	0.018**	-0.041**	0.053***	0.027***	-0.023	0.016*
		(1.43)	(2.03)	(-2.34)	(5.02)	(3.57)	(-1.22)	(1.79)
L3. Tier 1 capital ratio (%)		-0.022***	-0.022***	0.003	0.007	-0.038***	0.005	-0.024***

		(-9.06)	(-5.20)	(0.53)	(1.05)	(-8.53)	(0.68)	(-5.63)
L3. Deposits-to-liabilities ratio (%)		0.001**	0.006***	0.006***	0.003***	0.008***	0.006***	0.006***
		(2.35)	(8.11)	(3.75)	(4.02)	(11.36)	(2.65)	(9.10)
L3. Loans-to-assets ratio (%)		-0.002***	0.002	0.005***	-0.000	0.002*	0.006***	0.000
		(-5.17)	(1.55)	(2.92)	(-0.02)	(1.88)	(2.61)	(0.36)
L3. Mortgages-to-assets ratio (%)		0.003***	-0.004***	-0.005***	-0.000	-0.002*	-0.006***	-0.003**
		(7.07)	(-2.80)	(-3.22)	(-0.20)	(-1.81)	(-3.13)	(-2.32)
Population of 20-25 and above 65 (%)		0.001	0.001	0.012	-0.004	-0.004	0.016	0.003
		(0.25)	(0.19)	(1.15)	(-0.73)	(-0.69)	(1.36)	(0.50)
High school or above (%)		0.005**	-0.007	-0.015*	-0.010	-0.016***	-0.024**	-0.005
		(2.22)	(-1.10)	(-1.71)	(-1.48)	(-3.26)	(-2.24)	(-0.80)
Female population (%)		0.019***	0.002	0.044	0.003	0.031	0.062	-0.008
		(2.93)	(0.09)	(1.33)	(0.11)	(1.56)	(1.63)	(-0.32)
Minority population (%)		0.000	0.009**	-0.011*	0.009**	0.006	-0.011*	0.009**
		(0.32)	(2.32)	(-1.80)	(2.11)	(1.37)	(-1.65)	(2.31)
Social capital index		-0.071***	-0.025	-0.033	0.053	-0.125**	-0.017	-0.027
		(-4.66)	(-0.41)	(-0.25)	(0.85)	(-2.52)	(-0.12)	(-0.51)
Branch FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Adjusted *R*-squared	0.192	0.212	0.355	0.336	0.404	0.317	0.350	0.358
Observations	69,108	69,108	13,189	7,098	10,369	13,584	5,429	12,038
No. of branches	7,006	7,006	1,361	888	1,149	1,214	516	1,254
SE Cluster	Branch	Branch	Branch	Branch	Branch	Branch	Branch	Branch
Test of difference in coefficient *p*-value (two-tailed)	N/A	N/A	N/A	N/A	N/A	N/A	0.064	

Notes. We present results obtained using Eq. 1. The dependent variable is the logarithm of branch deposits (in $000) and the main explanatory variable is an interaction term between the dummy indicating MA-DIF membership and the dummy variable denoting the crisis period. In Panel A, the crisis period covers Q3:2007-Q2:2010. In Panel B, the crisis period covers Q3:2007-Q2:2008. Column (1) uses the full sample, including branches of all banks from Massachusetts, New York, New Hampshire, Connecticut, Vermont, and Rhode Island. Column (2) presents the results with a set of 3 year-lagged bank-level control variables, including the logarithm of total bank assets (*Total assets (ln)*); the percentage of total interest expense on deposits over total deposits (*Interest expense ratio (%)*); the ratio of charged off loans over total loans (*Charge off ratio (%));* the Tier 1 capital ratio (*Tier 1 capital ratio (%)*); the ratio of total deposits over total liabilities *(Deposits-to-liabilities ratio (%))*; the ratio of total loans over total assets *(Loans-to-assets ratio (%))*; the ratio of total mortgages over total assets (*Mortgages-to-assets ratio(%)),* and a set of county-level variables, including the proportion of the population with high school or above education (*High school or above (%)*), the proportion of the population with age between 20 and 25 or above 65 (*Population of 20-25 and above 65 (%)*), the social capital index (*Social capital index*), the proportion of females (*Female population (%)*) and the proportion of minorities (*Minority population (%)*). Column (3) shows the results obtained using a sample covering branches of all banks operating in Massachusetts. Column (4) includes the results obtained using a sample including only Massachusetts branches of banks headquartered in Massachusetts (members and non-members of the MA-DIF). Column (5) includes the results obtained using a sample where the control group includes branches of banks headquartered outside Massachusetts. Column (6) includes the results obtained using a matched sample. Column (7) presents the results with a control group set of branches operated by banks with a lower volume of uninsured deposits in the pre-crisis period, while Column (8) presents the results with a control group set of branches operated by banks with a higher volume of uninsured deposits in the pre-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 pairs of the coefficient of interest equals 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 4

Effect of MA-DIF membership on branch-level deposits: Alternative explanations

Sample	All branches in MA							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	Branch deposits (ln)							
Control group split	Interest expense ratio (%)		Return on equity		Charge off ratio (%)		Z-score (ln)	
Percentile	≤ P50	> P50	≤ P50	> P50	≤ P50	> P50	≤ P50	> P50
Panel A								
Effect of MA-DIF membership on branch-level deposits (Crisis definition Q3:2007-Q2:2010)								
Membership*Crisis	0.079***	0.041***	0.086***	0.045***	0.083***	0.072***	0.036**	0.069***
	(5.73)	(3.18)	(6.97)	(2.74)	(3.43)	(6.12)	(2.28)	(4.95)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES
Branch FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Adjusted *R*-squared	0.314	0.384	0.338	0.385	0.354	0.350	0.419	0.299
Observations	7,201	10,266	11,628	5,839	5,099	12,368	7,980	9,487
No. of branches	689	1,081	1,175	595	506	1,264	788	982
SE Cluster	Branch	Branch	Branch	Branch	Branch	Branch	Branch	Branch
Test of difference in coefficient		0.044		0.045		0.683		0.117
p-value (two-tailed)								
Panel B								
Effect of MA-DIF membership on branch-level deposits (Crisis definition Q3:2007-Q2:2008)								
Membership*Crisis	0.120***	0.108***	0.113***	0.111***	0.133***	0.123***	0.057***	0.154***
	(5.85)	(7.00)	(7.37)	(4.87)	(4.55)	(8.38)	(3.30)	(7.45)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES
Branch FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Adjusted *R*-squared	0.314	0.385	0.337	0.386	0.354	0.351	0.419	0.302
Observations	7,201	10,266	11,628	5,839	5,099	12,368	7,980	9,487
No. of branches	689	1,081	1,175	595	506	1,264	788	982
SE Cluster	Branch	Branch	Branch	Branch	Branch	Branch	Branch	Branch
Test of difference in coefficient		0.640		0.943		0.760		0.000
p-value (two-tailed)								

Notes. We present results obtained using Eq. 1. The dependent variable is the logarithm of branch deposits (in $000) and the main explanatory variable is an interaction term between the dummy indicating MA-DIF membership and the dummy variable denoting the crisis period. In Panel A, the crisis period covers Q3:2007-Q2:2010. In Panel B, the crisis period covers Q3:2007-Q2:2008. Column (1) presents the results with a control group of branches operated by banks with a lower interest expense ratio in the pre-crisis period, while Column (2) presents the results with a control group of branches operated by banks with a higher interest expense ratio in the pre-crisis period. Column (3) presents the results of a sample where the control group includes branches of banks with a lower return on equity (ROE), while Column (4) presents the results of a sample where the control group includes branches of banks with a higher return on equity (ROE). Column (5) presents the results of a sample where the control group includes branches of banks with a lower charge off ratio, while Column (6) presents the results of a sample where the control group includes branches of banks with a higher charge off ratio. Column (7) presents the results with a control group of branches operated by banks with a lower Z-score in the pre-crisis period, while Column (8) presents the results with a control group of branches operated by banks with a higher Z-score in the pre-crisis period. Definitions of all control variables are shown in the notes of Table 3. 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 pairs of the coefficient of interest equals 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 5

Effect of MA-DIF membership on bank lending

Panel A

Effect of MA-DIF membership on bank lending during the crisis (total loans and loans with different maturities)

Dependent variable	(1) Total loans	(2) Loans with maturity below 5 years	(3) Loans with maturity between 5-15 years
Membership*Crisis	0.068**	0.007	0.279***
	(2.36)	(0.14)	(2.92)
Control variables	YES	YES	YES
Bank FE	YES	YES	YES
Year FE	YES	YES	YES
Adjusted *R*-squared	0.823	0.538	0.513
Observations	3,449	3,449	3,449
No. of banks	83	83	83
SE Cluster	Bank	Bank	Bank

Panel B

Effect of MA-DIF membership on bank lending during the crisis (different categories of loans)

Dependent variable	(1) Residential mortgages	(2) Construction and land development loans	(3) Commercial and industrial loans	(4) Individual loans
	(1)	(2)	(3)	(4)
Membership*Crisis	0.058**	0.138	0.066	0.198
	(2.18)	(0.86)	(0.47)	(1.57)
Control variables	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Adjusted *R*-squared	0.782	0.135	0.318	0.127
Observations	3,449	3,449	3,449	3,449
No. of banks	83	83	83	83
SE Cluster	Bank	Bank	Bank	Bank

Notes. We present results obtained using Eq. 2. The main explanatory variable is an interaction term between the dummy indicating MA-DIF membership and the dummy variable denoting the crisis period. The crisis period in both panels covers Q3:2007-Q2:2010. In Panel A, the dependent variable in Column (1) is the logarithm of total loans (in $000). The dependent variable in Column (2) is the logarithm of total loans with maturity below 5 years (in $000). The dependent variable in Column (3) is the logarithm of loans with maturity between 5-15 years (in $000). In Panel B, the dependent variable in Column (1) is the logarithm of residential mortgages (in $000). The dependent variable in Column (2) is the logarithm of construction and land development loans (in $000). The dependent variable in Column (3) is the logarithm of commercial and industrial loans (in $000). The dependent variable in Column (4) is the logarithm of individual loans (in $000). Definitions of all other control variables are shown in the notes of Table 3. 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 6

Effect of MA-DIF membership on residential mortgage origination and securitization

Panel A			
Effect of MA-DIF membership on mortgage origination			
	(1)	(2)	(3)
Dependent variable	Acceptance of loan applications		
Sample	All mortgages	Home purchase mortgages	Refinancing mortgages
Membership*Crisis	0.011***	0.025***	-0.002
	(2.90)	(4.28)	(-0.47)
Control variables	YES	YES	YES
Loan level characteristics	YES	YES	YES
Bank FE	YES	YES	YES
County x Year FE	YES	YES	YES
Adjusted *R*-squared	0.054	0.048	0.065
Observations	371,898	184,174	187,724
No. of banks	83	83	83
Panel B			
Effect of MA-DIF membership on mortgage securitization			
	(1)	(2)	
Dependent variables	Securitized mortgages (ln)	Proportion of securitized mortgages (%)	
Membership*Crisis	0.085	3.542	
	(0.89)	(0.99)	
Control variables	YES	YES	
Bank FE	YES	YES	
Year FE	YES	YES	
Adjusted *R*-squared	0.013	0.009	
Observations	3,449	3,449	
No. of banks	83	83	
SE Cluster	Bank	Bank	

Notes. In Panel A, we present results obtained using the following linear probability model: $Accept_{a,i,t} = \beta_0 + \beta_1 Membership_i \times Crisis_t + \delta X_{i,t} + \alpha Z_a + \gamma_i + \gamma_{c,t} + \epsilon_{a,i,t}$ where the dependent variable $Accept_{a,i,t}$, is a dummy variable indicating whether a loan application *a* is approved by bank *i* in year *t* and the main explanatory variable is an interaction term between the dummy variable, $Membership_i$, indicating MA-DIF membership, and the dummy variable, $Crisis_t$, denoting the crisis period. $X_{i,t}$ captures a vector of time-varying bank-level control variables, and $Z_{a,}$ captures a vector of loan-level control variables. γ_i is a bank fixed effect and $\gamma_{c,t}$ is a county × year fixed effect. The crisis period covers the years 2007-2010. Column (1) presents the results with a sample of all mortgage applications. Column (2) presents the results with a sample of home purchase mortgage applications. Column (3) presents the results with a sample of refinancing mortgage applications. In Panel B, we present results obtained using Eq. 2. The main explanatory variable is an interaction term between the dummy indicating MA-DIF membership and the dummy variable denoting the crisis period. The dependent variable in Column (1) is the logarithm of the volume of securitized residential mortgages (in $000). The dependent variable in Column (2) is the proportion of securitized residential mortgages to total residential mortgages. Definitions of all control variables are shown in the notes of Table 3. 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 7

Effect of MA-DIF membership on bank soundness

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Tier 1 capital ratio (%)	Charge off ratio (%)	Z-score	Nonperforming $mortgages_{t+4\ quarters}$ to total $mortgages_{t}$	Nonperforming $mortgages_{t+8\ quarters}$ to total $mortgages_{t}$	Nonperforming $mortgages_{t+12\ quarters}$ to total $mortgages_{t}$
Panel A						
Effect of MA-DIF membership on bank soundness (Crisis definition Q3:2007-Q2:2010)						
Membership*Crisis	0.036	-0.009	3.850	-0.001	0.001	-0.000
	(1.43)	(-0.88)	(0.36)	(-0.38)	(0.35)	(-0.02)
Bank-level control variables	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Adjusted *R*-squared	0.230	0.081	0.0303	0.355	0.322	0.275
Observations	3,449	3,449	3,449	3,388	3,302	3,217
No. of banks	83	83	83	82	79	79
SE Cluster	Bank	Bank	Bank	Bank	Bank	Bank
Panel B						
Effect of MA-DIF membership on bank soundness (Crisis definition Q3:2007-Q2:2008)						
Membership*Crisis	0.059**	-0.007	11.658	0.000	-0.007	0.003
	(2.45)	(-0.51)	(1.30)	(0.04)	(-1.40)	(0.67)
Bank-level control variables	YES	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Adjusted *R*-squared	0.232	0.0806	0.0303	0.355	0.322	0.275
Observations	3,449	3,449	3,449	3,388	3,302	3,217
No. of banks	83	83	83	82	79	79
SE Cluster	Bank	Bank	Bank	Bank	Bank	Bank

Notes. We present results obtained using Eq. 2. The main explanatory variable is an interaction term between the dummy indicating MA-DIF membership and the dummy variable denoting the crisis period. In Panel A, the crisis period covers Q3:2007-Q2:2010. In Panel B, the crisis period covers Q3:2007-Q2:2008. The dependent variable in Column (1) is the Tier 1 capital ratio (%). The dependent variable in Column (2) is the charge off ratio (%). The dependent variable in Column (3) is the Z-score. The dependent variable in Columns (4) - (6) is the nonperforming $mortgages_{t+4quarters}$ ratio, nonperforming $mortgages_{t+8quarters}$ ratio and nonperforming $mortgages_{t+12quarters}$ ratio, respectively. Definitions of all control variables are shown in the notes of Table 3. Robust *t*-statistics are presented in parentheses. Standard errors are clustered at the bank-level. *** p<0.01, ** p<0.05, * p<0.10.

Table 8

Effect of MA-DIF membership on the Loan-to-income ratio

	(1)	(2)	(3)
Dependent variables		Loan-to-income ratio (ln)	
Effect of MA-DIF on loan-to-income ratio			
Sample	All mortgages	Retained mortgages	Sold mortgages
Membership*Crisis	-0.057***	-0.135***	-0.013
	(-6.93)	(-10.01)	(-1.43)
Bank-level control variables	YES	YES	YES
Loan level characteristics	YES	YES	YES
Bank FE	YES	YES	YES
County x Year FE	YES	YES	YES
Adjusted *R*-squared	0.238	0.256	0.300
Observations	291,605	176,243	115,362
No. of banks	83	83	83
SE Cluster	Bank	Bank	Bank

Notes. We present results using the following multiple linear regression model. $LIR_{a,i,t} = \beta_0 + \beta_1 Membership_i \times Crisis_t + \delta X_{i,t} + \alpha Z_a + \gamma_i + \gamma_{c,t} + \epsilon_{a,i,t}$ where the dependent variable $LIR_{a,i,t}$, is the logarithm of loan-to-income ratio of approved mortgages *a* issued by bank i in year t and the main explanatory variable is an interaction term between the dummy variable, $Membership_i$, indicating MA-DIF membership, and the dummy variable, $Crisis_t$, denoting the crisis period. $X_{i,t}$ captures a vector of bank-level control variables, and Z_a captures a vector of loan-level control variables. γ_i is a bank fixed effect and $\gamma_{c,t}$ is a county × year fixed effect. The crisis period covers the years 2007-2010. Column (1) presents the results with a sample of all approved mortgage applications. Column (2) presents the results with a sample of approved retained mortgage applications. Column (3) presents the results with a sample of approved sold mortgage applications. Definitions of all control variables are shown in the notes of Table 3. Robust *t*-statistics are presented in parentheses. Standard errors are clustered at the bank-level. *** p<0.01, ** p<0.05, * p<0.1.

Internet Appendix

Private deposit insurance, deposit flows, bank lending, and moral hazard

Appendix A: Depositors' awareness and further details about the MA-DIF

Google Trends provides additional evidence that suggests an increasing interest in the MA-DIF during the crisis. Figure A.1 shows the monthly Google Trends index in 2004-2015, indicating the search volume for the term "Depositors Insurance Fund" in Massachusetts. Prior to the crisis, the index constantly stays at zero, indicating that the public paid little attention to the MA-DIF. However, the search volume index increases at the onset of the 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 MA-DIF increases amid greater concern about financial system soundness.

[FIGURE A.1]

Table A.1 compares in Panel A design features of the MA-DIF with the FDIC. Panel B contrasts four characteristics of successful insurance mechanisms with those that failed in the U.S. to evaluate the credibility of the MA-DIF based on historical experience. This comparison considers both the experience of bank liability insurance funds in the Antebellum era and deposit insurance funds after the Antebellum era to gain a holistic overview. During the Antebellum era, some of the schemes insured all debt of the participating banks, i.e., circulating notes and deposits, while some of them only insured circulating notes (Golembe and Warburton (1958)). To avoid any confusion with the labelling used in prior work, we follow Calomiris (1989) and use the phrase 'bank insurance' to cover both bank liability insurance in the Antebellum era and deposit insurance after the Antebellum era in this Appendix.

Calomiris (1989) defines a successful bank insurance fund as one that completely protects the payment system without motivating risk-taking of banks, while a failure is defined as a situation where a bank insurance fund fails to protect the payment system or collapses due to design flaws.

[Table A.1]

Panel A highlights two distinguishing features between the MA-DIF and the FDIC: the unlimited insurance coverage for deposits held in member banks of the MA-DIF and its private management. A detailed review of the design features of the MA-DIF suggests that many of its

characteristics resemble those of successful bank insurance funds in the past.

(i) Power to regulate and discipline banks

For most of the successful 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)).

While the management board of the MA-DIF is less powerful compared with successful bank insurance funds in the past, its management board 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 MA-DIF member banks are already monitored by the FDIC and the Massachusetts Division of Banks. The MA-DIF may therefore not need to have strong board power.

(ii) Cost of exit

The low cost of exit contributes to adverse selection problems that undermine the reliability of the bank insurance funds (English (1993)). The cost of exit is high when the board of the deposit insurance fund can restrict exit and exit undermines banks' competitive advantage. Membership in the MA-DIF is compulsory for all Massachusetts-chartered savings banks, MA-DIF member banks can only leave the fund by switching their charter.

(iii) Reserves to cover insured liabilities

A common characteristic of failed insurance funds are 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)).

The MA-DIF maintained sufficient reserves to survive the worst financial period in the history of the Massachusetts savings bank industry in the early 1990s. Back then, the MA-DIF was capable to pay out more than 50 million USD to protect over 6,500 depositors in 19 failed member banks.

Figure A.2 compares the gross coverage ratio of the MA-DIF with the equivalent figure of the

FDIC.[13] While fundamental differences between the FDIC and the MA-DIF render the comparison imperfect, the figure serves to illustrate whether the MA-DIF was financially vulnerable during the recent financial crisis by comparing the evolution of its gross coverage ratio to the FDIC.[14] We define the gross coverage ratio as total assets over insured deposits.[15] The gross coverage ratio of the MA-DIF is higher than the ratio of the FDIC. The gross coverage ratio of the MA-DIF ranges from 3.5 % to 6 %, while the coverage ratio for the FDIC stays below 2%. The gross coverage ratio of both insurance funds rises during the crisis. The adjustment of the FDIC deposit insurance limit causes a sharp increase in the gross coverage ratio of the MA-DIF in 2008. In short, there is no evidence showing an abnormal decline of the gross coverage ratio of the MA-DIF during the crisis.

[FIGURE A.2]

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

(v) Management board consisting of member banks' management

The board of directors in a successful bank insurance fund generally consist of the managers of its member banks (Calomiris (1989)). While this composition ensures that the board members of the bank insurance fund have skin in the game, it also lowers the monitoring cost of the board in the sense that the managers of member banks tend to know more about their peers and the local environment than outsiders

[13] Data on gross coverage ratios of the MA-DIF and the FDIC is available in the respective annual reports.

[14] A key distinguishing feature between both insurance schemes is that the FDIC is backed by the full faith and credit of the U.S. government, while the MA-DIF is neither backed by the federal nor the state government. The FDIC can rely on a line of credit from the U.S. Treasury when reserves disappear, but the MA-DIF does not have such backup.

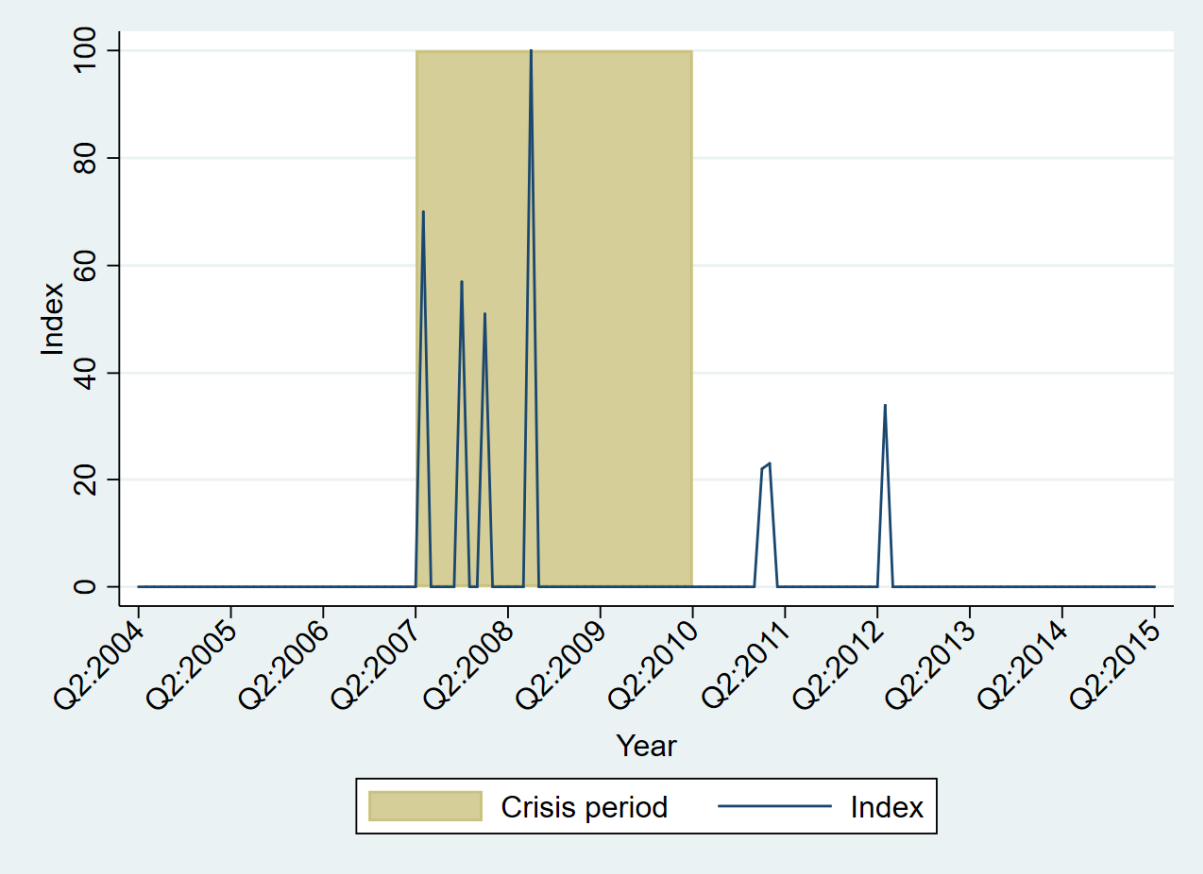
[15] Total assets of the MA-DIF amount to 355 million USD in 2008.

appointed by regulatory authorities. 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 MA-DIF primarily consists of presidents and chief executive officers of the MA-DIF-insured banks.

Our brief survey suggests that the MA-DIF is designed with an incentive compatible mechanism, and sufficient reserves against losses. These factors are likely to have played a major role for the survival of the MA-DIF during numerous crises since 1934.

Figure A.1

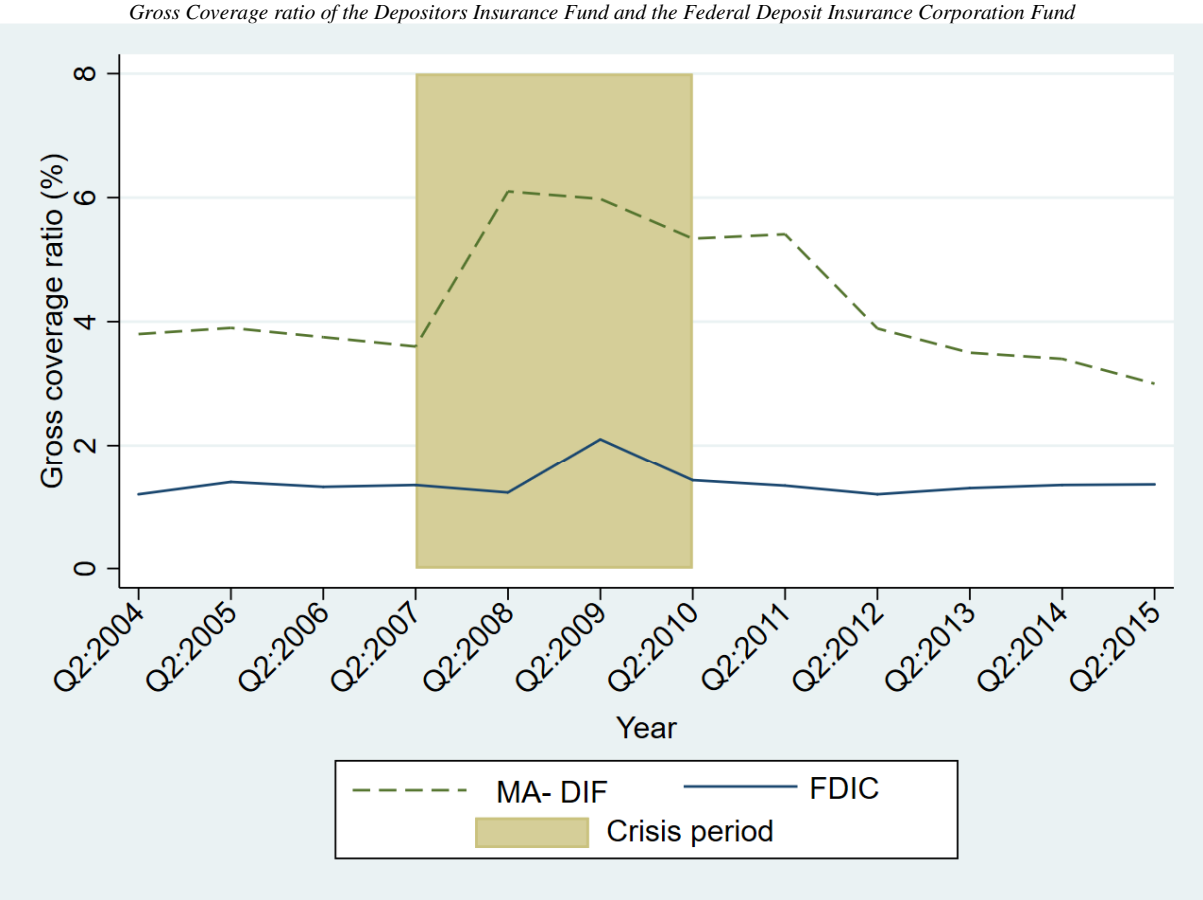
Google Trends search volume index of the keyword "Depositors Insurance Fund"



Notes. This figure presents the Google Trends search volume index for the keywords "Depositors Insurance Fund" in Massachusetts between 2004 and 2015. The shaded area indicates the crisis period (Q3:2007-Q2:2010).

Figure A.2

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



Notes. This figure compares the gross coverage ratio of the MA-DIF and the FDIC during 2004-2015. The shaded area indicates the crisis period (Q3:2007-Q2:2010).

Table A.1

Comparison between the MA-DIF and other deposit insurance funds

Panel A			
Comparison of the MA-DIF with the FDIC			
Deposit insurance / Characteristics	MA-DIF		FDIC
Explicit	Yes		Yes
Coverage limit	Unlimited		250,000 USD
Coinsurance	No		No
Sources of funds	Banks		Banks
Management	Private		Public
Membership	Compulsory for MA-chartered savings banks		Compulsory
Risk adjusted premium	Yes		Yes
Panel B			
Comparison of successful and failed bank insurance funds and the MA-DIF			
Bank insurance funds / Characteristics	Successful during and after the Antebellum period	Failed during and after the Antebellum period	MA-DIF
Power to regulate and discipline banks	Yes	No	Yes
Reserve to cover insured deposits	Abundant	Limited	Abundant
Management primarily comprises member banks' management	Yes	No	Yes
Risk adjusted premium	Yes	No	Yes

Notes. Panel A compares characteristics of the MA-DIF and the FDIC. Panel B compares characteristics of the MA-DIF to successful and failed bank insurance funds in the U.S.

Appendix B: Selection into membership

To mitigate the concern over membership selection, our baseline results exclude banks without consistent membership status during the sample period in Massachusetts. Here, we show that the results are robust to the inclusion of this group of banks.

We replicate the test presented in Table 3 and show the replicated results in Column (1) - (5) of Table B.1. The only difference between Table 3 and Table B.1 is that the sample in Column (1) - (5) of Table B.1 (Table 3) includes (excludes) banks that switch MA-DIF membership status during the sample period. These banks do not have consistent membership status, mainly because of mergers and acquisitions, changes in charters, and bank failures. Column (1) - (5) of Table B.1 show that our results are robust to the inclusion of this group of banks. The results of Column (1) – (3) also suggest that non-member banks switching to member status receive additional deposits, even in non-crisis period.

Table B.1

Effect of MA-DIF membership on branch-level deposits (including banks which switch membership)

	(1)	(2)	(3)	(4)	(5)
Panel A					
Effect of MA-DIF membership on branch-level deposits (Crisis definition Q3:2007-Q2:2010)					
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
Membership*Crisis	0.024***	0.023***	0.073***	0.038**	0.078***
	(2.79)	(2.74)	(6.73)	(2.52)	(6.94)
Membership	0.070*	0.081**	0.089**	0.055	0.050
	(1.73)	(2.09)	(2.02)	(1.51)	(0.92)
Control variables	NO	YES	YES	YES	YES
Branch FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Adjusted *R*-squared	0.190	0.210	0.339	0.312	0.385
Observations	69,877	69,877	13,817	7,726	10,997
No. of branches	7,067	7,067	1,421	951	1,229
SE Cluster	Branch	Branch	Branch	Branch	Branch
Panel B					
Effect of MA-DIF membership on branch-level deposits (Crisis definition Q3:2007-Q2:2008)					
Membership*Crisis	0.037***	0.063***	0.130***	0.091***	0.118***
	(3.23)	(5.40)	(9.39)	(4.32)	(8.86)
Membership	0.070*	0.078**	0.089**	0.052	0.054
	(1.75)	(2.00)	(2.06)	(1.45)	(1.01)
Control variables	NO	YES	YES	YES	YES
Branch FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Adjusted *R*-squared	0.190	0.210	0.340	0.313	0.385
Observations	69,877	69,877	13,817	7,726	10,997
No. of branches	7,067	7,067	1,421	951	1,229
SE Cluster	Branch	Branch	Branch	Branch	Branch

Notes. We present results obtained using Eq. 1. The dependent variable is the logarithm of branch deposits (in $000) and the main explanatory variable is an interaction term between the dummy indicating MA-DIF membership and the dummy variable denoting the crisis period. In Panel A, the crisis period covers Q3:2007-Q2:2010. In Panel B, the crisis period covers Q3:2007-Q2:2008. Column (1) uses the full sample, including branches of all banks from Massachusetts, New York, New Hampshire, Connecticut, Vermont, and Rhode Island. Column (2) presents the results with a set of 3 year-lagged bank-level control variables. Column (3) shows the results obtained using a sample covering branches of all banks operating in Massachusetts. Column (4) includes the results obtained using a sample including only Massachusetts branches of banks headquartered in Massachusetts (members and non-members of the MA-DIF). Column (5) includes the results obtained using a sample where the control group includes branches of banks headquartered outside Massachusetts. Definitions of all control variables are shown in the notes of Table 3. Robust *t*-statistics are presented in parentheses. Standard errors are clustered at the branch-level. *** p<0.01, ** p<0.05, * p<0.1.

Appendix C: Further robustness tests

Table C.1

Effect of MA-DIF membership on market shares and scaled branch-level deposits of MA-DIF member banks

	(1)	(2)
Dependent variable	Market share (ln)	Branch deposits scaled by total assets (ln)
Sample	All branches in MA	
Panel A		
Effect of MA-DIF membership on market share and scaled branch-level deposits (Crisis definition Q3:2007-Q2:2010)		
Membership*Crisis	0.071***	0.074***
	(5.57)	(6.58)
Control variables	YES	YES
Branch FE	YES	YES
Year FE	YES	YES
Adjusted *R*-squared	0.444	0.846
Observations	13,189	13,189
No. of branches	1,361	1,361
SE Cluster	Branch	Branch
Panel B		
Effect of MA-DIF membership on market share and scaled branch-level deposits (Crisis definition Q3:2007-Q2:2008)		
Membership*Crisis	0.129***	0.129***
	(8.46)	(8.91)
Control variables	YES	YES
Branch FE	YES	YES
Year FE	YES	YES
Adjusted *R*-squared	0.444	0.846
Observations	13,189	13,189
No. of branches	1,361	1,361
SE Cluster	Branch	Branch

Notes. We present the results obtained using Eq. 1. The sample cover branches of all banks operating in Massachusetts and the main explanatory variable is an interaction term between the dummy indicating MA-DIF membership and the dummy variable denoting the crisis period. In Panel A, the crisis period covers Q3:2007-Q2:2010. In Panel B, the crisis period covers Q3:2007-Q2:2008. The dependent variable in Column (1) is the logarithm of the market share, defined as branch-level deposits to total deposits of all branches operating in Massachusetts. The dependent variable in Column (2) is the logarithm of branch deposits scaled by total assets, defined as branch-level deposits to 3 year-lagged total assets. Definitions of all control variables are shown in the notes of Table 3. 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 C.2

Effect of MA-DIF membership on interest expense ratio

Dependent variable	Interest expense ratio (%)
Panel A	
Effect of MA-DIF membership on average interest expense ratio (Crisis definition Q3:2007-Q2:2010)	
Membership*Crisis	0.019
	(0.98)
Control variables	YES
Bank FE	YES
Year FE	YES
Adjusted *R*-squared	0.932
Observations	3,449
No. of banks	83
SE Cluster	Bank
Panel B	
Effect of MA-DIF membership on average interest expense ratio (Crisis definition Q3:2007-Q2:2008)	
Membership*Crisis	-0.006
	(-0.59)
Control variables	YES
Bank FE	YES
Year FE	YES
Adjusted *R*-squared	0.917
Observations	3,449
No. of banks	83
SE Cluster	Bank

Notes. We present results obtained using Eq. 2. The main explanatory variable is an interaction term between the dummy indicating MA-DIF membership and the dummy variable denoting the crisis period. In Panel A, the crisis period covers Q3:2007-Q2:2010. In Panel B, the crisis period covers Q3:2007-Q2:2008. The dependent variable in this table is the interest expense ratio (%). Definitions of all control variables are shown in the notes of Table 3. 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 C.3

Effect of MA-DIF membership on bank-level deposits (interaction with average interest expense ratio)

Dependent variable	Bank-level deposits (ln)
Effect of MA-DIF membership on bank-level deposits (Crisis definition Q3:2007-Q2:2010)	
Membership*Crisis	0.074***
	(2.69)
Membership*Crisis*Interest expense ratio (%)	0.100**
	(2.09)
Control variables	YES
Bank FE	YES
Year FE	YES
Adjusted *R*-squared	0.757
Observations	3,449
No. of banks	83
SE Cluster	Bank

Notes. We present results using the following multiple linear regression model. $Deposits_{i,t} = \beta_0 + \beta_1 Membership_i \times Crisis_t + \beta_2 Membership_i \times Crisis_t \times Interest\ Expense\ ratio_{i,t} + \delta X_{i,t} + \gamma_i + \gamma_t + \epsilon_{a,i,t}$ where the dependent variable $Deposits_{i,t}$ is the logarithm of bank-level deposits of bank *i* in year *t*, $Crisis_t$, denoting the crisis period, Q3:2007-Q2:2010, and $Interest\ Expense\ ratio_{i,t}$ is the percentage of total interest expense over total deposits. $X_{i,t}$ captures a vector of control variables, and γ_i captures bank fixed effects and γ_t captures quarter fixed effects. Definitions of all control variables are shown in the notes of Table 3. 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 C.4

Placebo tests and deposit flows in savings banks in the neighboring states

Panel A					
Monte Carlo simulations for the effect of MA-DIF membership on branch-level deposits during the crisis					
Dependent variable			Branch-level deposits (ln)		
Rejection rate at the 1 % level (2-tailed test)			1.3%		
Rejection rate at the 5 % level (2-tailed test)			5.8%		
Rejection rate at the 10 % level (2-tailed test)			10.6%		
Mean coefficient			0.009		
(*t*-statistic)			(0.06)		
Panel B					
Deposits of savings banks in the five neighbouring states of Massachusetts during the crisis					
	(1)	(2)	(3)	(4)	(5)
Dependent variable			Branch-level deposits (ln)		
Sample	All branches in CT	All branches in NH	All branches in NY	All branches in RI	All branches in VT
Savings Bank* Crisis	0.039	0.058	0.005	0.020	-0.045
	(1.43)	(1.20)	(0.36)	(0.28)	(-0.85)
Control variables	YES	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Adjusted *R*-squared	0.330	0.276	0.232	0.257	0.327
Observations	3,647	1,595	17,434	1,734	1,117
No. of banks	439	226	3,168	178	107
SE Cluster	Branch	Branch	Branch	Branch	Branch

Notes. Panel A presents the placebo test results with a random selection of membership in the MA-DIF. We report Monte Carlo simulations based on 1,000 replications for the effect of MA-DIF membership on branch-level deposits. We estimate Eq. 1 using the full sample of branch-level data. We exclude MA-DIF member banks and randomly assign banks to placebo MA-DIF membership status and set the variable *"Membership"* equal to 1 for 'member' banks and equal to 0 for 'non-member' banks. We estimate the regression and save the *t*-statistic on the coefficient of interest and repeat this process 1,000 times and compute the rejection rates of the null hypothesis =0 at the 1%, 5%, and 10% levels, respectively. We also report the mean coefficient and the average *t*-statistic for β_1.In Panel B, we present results obtained using Eq. 1 but focus on the five surrounding states. The dependent variable is the logarithm of branch deposits (in $000), but the main explanatory variable is an interaction term between the dummy indicating state-chartered savings banks and the dummy variable denoting the crisis period. 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 C.5

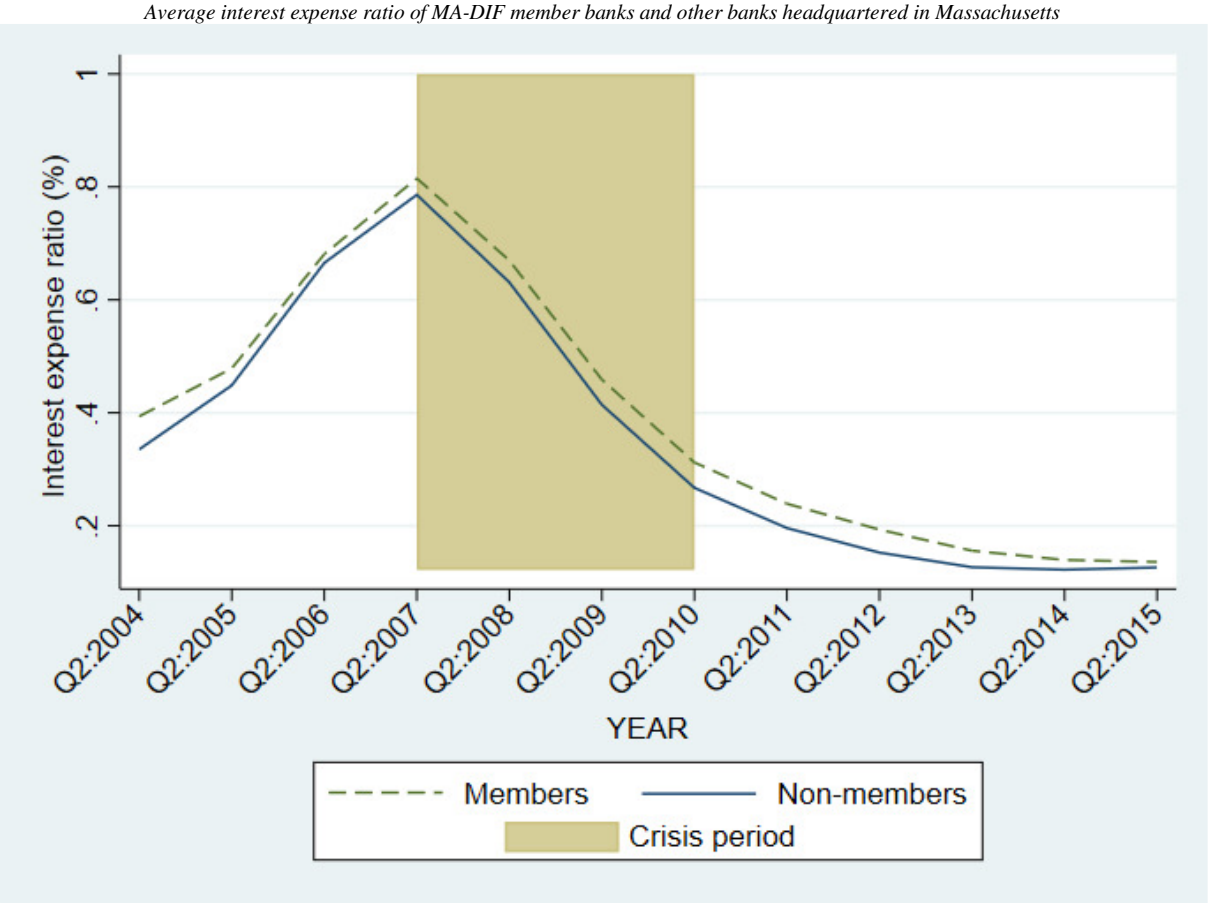
Effect of MA-DIF membership on branch-level deposits

	(1)	(2)	(3)	(4)	(5)
Dependent variable	**Branch deposits (ln)**				
Sample	All branches in MA				
Panel A					
Effect of MA-DIF membership on branch-level deposits (Crisis definition Q3:2007-Q2:2010)					
Membership*Crisis	0.068***	0.068***	0.067***	0.073***	0.074***
	(6.15)	(3.32)	(5.69)	(2.83)	(6.17)
Crisis	-0.001				
	(-0.12)				
Membership	0.151*				
	(1.88)				
Control variables	YES	YES	YES	YES	YES
Bank FE	NO	YES	NO	NO	NO
Branch FE	NO	NO	YES	YES	YES
County x Year FE	NO	NO	YES	NO	NO
Year FE	NO	YES	NO	YES	YES
Adjusted *R*-squared	0.334	0.193	0.945	0.944	0.280
Observations	13,189	13,189	13,189	13,189	13,189
No. of branches	1,361	1,361	1,361	1,361	1,361
SE cluster	Branch	Branch	Branch	Bank	Bootstrap
Panel B					
Effect of MA-DIF membership branch-level deposits (Crisis definition Q3:2007-Q2:2008)					
Membership*Crisis	0.109***	0.105***	0.114***	0.130***	0.129***
	(7.84)	(4.71)	(7.56)	(4.90)	(8.68)
Crisis	-0.070***				
	(-8.27)				
Membership	0.147*				
	(1.85)				
Control variables	YES	YES	YES	YES	YES
Bank FE	NO	YES	NO	NO	NO
Branch FE	NO	NO	YES	YES	YES
County x Year FE	NO	NO	YES	NO	NO
Year FE	NO	YES	NO	YES	YES
Adjusted *R*-squared	0.334	0.193	0.945	0.944	0.280
Observations	13,189	13,189	13,189	13,189	13,189
No. of branches	1,361	1,361	1,361	1,361	1,361
SE cluster	Branch	Branch	Branch	Bank	Bootstrap

Notes. We present the results obtained using variations of Eq. 1 with alternative fixed effects and methods in adjusting standard errors. The dependent variable is the logarithm of branch deposits (in $000). The main explanatory variable is an interaction term between the dummy indicating MA-DIF membership and the dummy variable denoting the crisis period. In Panel A, the crisis period covers Q3:2007-Q2:2010. In Panel B, the crisis period covers Q3:2007-Q2:2008. In Column (1) - (3), we present the results obtained using variations of Eq. 1 with alternative fixed effects. Column (1) show the results without any fixed effects. Column (2) presents the results with bank-fixed effects, rather than branch-fixed effects. Column (3) introduces the interaction of county-fixed effects with and year-fixed effects into the model. In Column (4) - (5), we present the results obtained using variations of Eq. 1 with alternative methods of adjusting stand errors. Column (4) are clustered at the bank-level, while standard errors in Column (5) are bootstrapped based on 600 bootstrap simulations. Definitions of all control variables are shown in the notes of Table 3. Robust *t*-statistics are presented in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure C.1

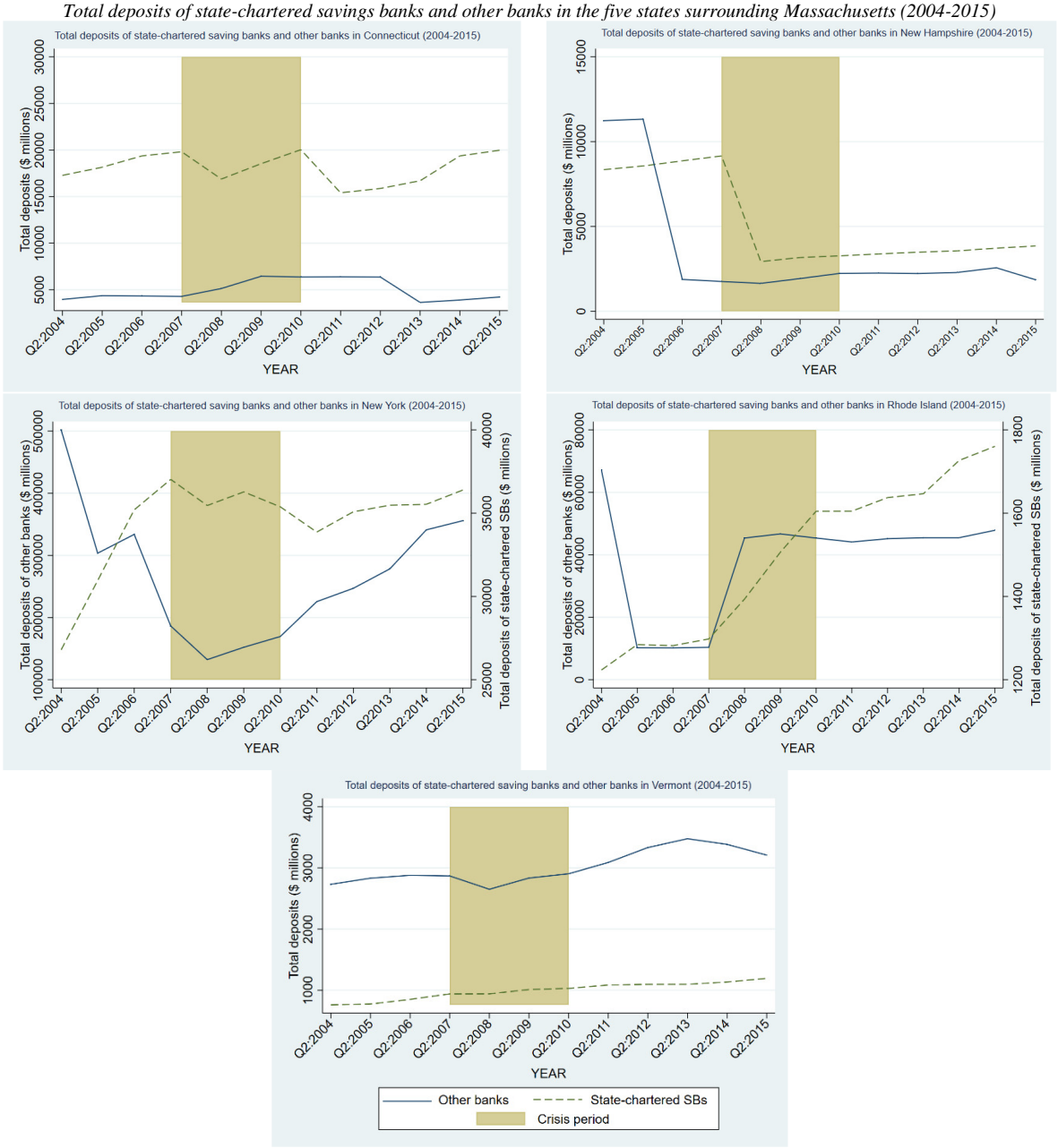
Average interest expense ratio of MA-DIF member banks and other banks headquartered in Massachusetts



Notes. This figure presents the average interest expense ratio of MA-DIF member banks and non-member banks headquartered in Massachusetts. The dashed line represents the average interest expense ratio of deposits of the MA-DIF members, while the solid line represents the average interest expense ratio of deposits of non-member banks. The interest expense ratio is the ratio of total interest expense on deposits over total deposits. The shaded area indicates the crisis period (Q3:2007-Q2:2010).

Figure C.2

Total deposits of state-chartered savings banks and other banks in the five states surrounding Massachusetts (2004-2015)



Notes. This figure shows total deposits of state-chartered savings banks and other banks headquartered in the respective five states surrounding Massachusetts in 2004-2015. The dashed line represents the total deposits of state-chartered savings banks, while the solid line represents the total deposits of all other banks. The shaded area indicates the crisis period (Q3:2007-Q2:2010). Total deposits are scaled by 1,000,000.