The Distortive Effects of Too-Big-To-Fail: Evidence from the Danish Market for Retail Deposits [*]

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Abstract

We study the impact of too big to fail (TBTF) guarantees on bank competition for retail deposits. Exploiting information about all personal deposit accounts in Denmark and salient changes to the deposit insurance limit, we provide evidence that systemically important banks successfully retain and attract uninsured deposits in a crisis at the expense of other banks even as they differentially lower their interest rates. The funding shock suffered by non-systemic banks causes a decrease in their lending. The results point to distortive effects of TBTF guarantees in the market for retail deposits.

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1. Introduction

Most governments explicitly guarantee the safety of bank deposits through deposit insurance schemes. Governments also make implicit guarantees that, unlike deposit insurance, are not enshrined in law to apply equally to all banks. By nature of being *implicit* governments often refer to such guarantees somewhat tangentially, calling the recipient banks "systemically important". In popular opinion, and on occasion confirmed as such by governments themselves, these guarantees reflect the fact that certain banks benefit from special government protection because they are *too big to fail* (TBTF).

An important concern about TBTF guarantees is that they may distort competition for deposits. When explicit deposit insurance is unlimited, TBTF guarantees should not matter for depositor choices: all deposits are safe, both in banks that are systemically important and in banks that are not. However, when deposit insurance is limited, TBTF guarantees may be distortive: deposit balances above the limit are generally at risk, but less so for deposits at systemic banks that are more likely to be bailed out in the event of distress. Arguably, the distortive effect is particularly pronounced in times of crisis when depositors fear for the safety of their savings.

The concern that TBTF guarantees may be distortive emerged clearly in the debate about the Temporary Liquidity Guarantee Program, a blanket guarantee on non-interest bearing transaction accounts issued by the U.S. government at the onset of the financial crisis in 2008. When the blanket guarantee was due to expire in 2012, "bankers at nearly all *but* the largest financial institutions […] pleaded with Congress to extend the program" (New York Times, 2012; emphasis our own). Invoking the competitive advantage conferred on large banks by TBTF guarantees, small banks expressed concerns that they would lose deposits if the blanket guarantee were to be removed.

In this paper, we investigate the distortions caused by TBTF guarantees by exploiting salient changes to deposit insurance in Denmark for empirical identification. To mitigate the effects of the global credit crunch, the Danish government chose to guarantee all bank liabilities in 2008. However, following a decision by the European Union to harmonize deposit insurance across its member states, insurance was limited at DKK 750,000 in 2010. The limit left around 20% of all retail deposits uninsured in a period with frequent bank failures. This course of events provides a useful laboratory for measuring the distortive effects of TBTF guarantees in the market for retail deposits. Intuitively, we can compare the distribution of deposits in the period with unlimited deposit insurance (2008-2009), where TBTF guarantees should have no effect on depositor choices, and the period with limited deposit insurance

(2010-2011), where TBTF guarantees may have affected the allocation of deposits above the insurance limit.

For the purposes of this analysis, we have access to a unique dataset with annual end-of-year balances for every bank account in Danish banks held by individuals during the period 2003-2011. To this dataset, we add detailed information about banks and account holders. We thus observe the total deposits held by each individual in the Danish banking system; how individuals allocate deposits across banks; how this allocation changes in response to the insurance limit; and how the magnitude of the responses depends on bank and depositor characteristics.

In the first step of the empirical analysis, we document that the deposit insurance limit induced significant depositor responses: individuals with deposits above the limit split their deposits across multiple accounts to remain fully insured, but did not withdraw deposits from the banking system.

We derive these results in various ways. First, we plot the distribution of deposit balances and document that significant bunching emerges at DKK 750,000 in 2010 in the account-level distribution, but not in the individual-level distribution. This is suggestive that depositors drew down account balances to the insurance limit (account-level bunching) while placing the excess balances on accounts in other banks (no individual-level bunching). Second, aggregating deposits in the same range and the same bank, we employ a regression framework. We show that account-level deposit balances above and below DKK 750,000 diverged sharply in 2010 with balances above the limit decreasing by around 50% relative to balances below. However, individual-level deposit balances above and below the limit followed the same trend throughout the estimation period. This confirms that depositors reallocated account balances above the insurance limit but did not withdraw funds from the banking system. Third, we study depositors' propensity to increase the number of accounts directly and document a sharp increase in splitting of deposit accounts in 2010, but only for individuals with deposits above DKK 750,000.

In the main analysis, we build on these results to show that the reallocation of deposits across accounts involved a systematic reallocation of deposits across banks: the six largest and systemically important banks were much more successful at retaining and attracting deposits above the insurance limit even as they differentially reduced interest rates on uninsured deposits. These results suggest that TBTF guarantees distort the market for retail deposits by reducing the perceived risk of holding uninsured deposits in systemic banks.

The finding that *deposit quantities* changed differentially in systemic and non-systemic banks emerges from analysis of the distribution of deposit balances across banks and a regression framework, mirroring our

approaches in the first stage of the analysis. In the account-level distribution of deposit balances, we find pronounced bunching at DKK 750,000 for non-systemic banks, but almost none for systemic banks. In a regression framework, we show that deposits above the insurance limit decreased by around 50% relative to deposits below in non-systemic banks, but only by around 20% in systemic banks. These results do not reflect a perception among depositors that larger banks are safer because of superior risk-management technologies or otherwise: the loss of uninsured deposits is increasing in bank size through the distribution, except at the very top where the six systemic banks suffered exceptionally small losses. Moreover, the results are unlikely to be confounded by factors correlating with systemic importance: the difference between systemic and non-systemic banks remains virtually unchanged when we simultaneously allow deposit losses to be heterogeneous in other bank characteristics (liquidity, capitalization and profitability) and average customer characteristics (gender, age and income).

Complementing the results on deposit quantities, we also show that *deposit prices* changed differentially in systemic and non-systemic banks when deposit insurance was limited: the interest rates on very large deposits was almost identical throughout the period 2006-2009 but then diverged in 2010, with systemic banks lowering their rates by around 0.4 percentage points relative to non-systemic banks. By contrast, interest rates on accounts below the insurance limit followed the same trend throughout the estimation period. The results imply that the differential shock to the supply of deposits above DKK 750,000 was even larger than suggested by the observed movements in deposit quantities: if systemic and non-systemic banks had continued to apply the same deposit prices, the divergence in deposit quantities would arguably have been even larger.

Losses of deposits may have repercussions in the real economy, as suggested by recent evidence that funding shocks to banks are transmitted to firms and households though credit supply (Chodorow-Reich, 2014; Jensen and Johannesen, 2017). In the last part of the analysis, we show that the reallocation of uninsured deposits towards TBTF banks affected lending. For identification, we exploit cross-sectional variation in exposure to the funding shock coming from differences in deposits above the insurance limit. We first show that a larger share of deposits above DKK 750,000 in 2007 was associated with less new lending over the period 2007-2011 but only for non-systemic banks. In an instrumental variables framework, we find that a 1% decrease in deposits in non-systemic banks, induced by the deposit reallocation, reduced their lending by 0.35%. This finding suggests that the funding shocks induced by the cut to the insurance limit were partly transmitted to the real economy through a contraction of bank lending.

This paper contributes to the literature on banks that are too-big-to-fail (Flannery, 2010; Strahan, 2013). Existing papers have examined equity market reactions to the announcement of TBTF guarantees (O'Hara and Shaw, 1990) and compared the sensitivity of bond yields to bank risk across periods where TBTF guarantees varied in strength (Flannery and Sorescu, 1996). While other related papers on the most recent crisis have shown that general government guarantees stimulated overall deposit growth in the banking sector (Acharya and Mora, 2015), our paper is the first to document the competitive distortions created by asymmetric guarantees in deposit markets.

Our results also contribute to the broader literature on how government interventions in the banking sector shape outcomes such as financial stability and competition. Cross-country studies find that explicit deposit insurance increases the likelihood of financial crisis (Demirgüç-Kunt and Detragiache, 2002; Demirgüç-Kunt et al., 2008) while other types of interventions, such as liquidity support, recapitalizations, and nationalizations, have been shown to increase competition (Calderon and Schaeck, 2016). The former result finds support in recent bank-level evidence that increases in deposit insurance induce banks to become more risky (Lambert, Noth, and Schüwer, 2017) while the latter result is consistent with the finding that higher perceived bailout probabilities increase the risk-taking of competitor banks (Gropp, Hakenes, and Schnabel, 2011). Our analysis contributes to this literature by showing that TBTF guarantees may destabilize the financial sector by tilting deposit market competition in favor of systemic banks and thus causing material funding shocks to non-systemic banks.

Our findings point to an important interplay between deposit insurance and TBTF guarantees, with implications for policy design. The key result is that depositors reallocate uninsured balances from non-systemic banks to systemic banks when they perceive a high risk of bank failures. If the insurance limit is high, only a fraction of deposits are uninsured and the scope for reallocation is limited. Conversely, if the insurance limit is low, large reallocations are possible and these movements could cause a severe funding shock to non-systemic banks. While TBTF guarantees add to the fragility of non-systemic banks, policymakers can mitigate this by raising the deposit insurance limit in times of crisis.

The rest of the paper proceeds as follows. Section 2 presents the institutional environment. Section 3 describes the data. Sections 4-6 present the results. Section 7 concludes.

2. Background

2.1 The financial crisis in Denmark

In the years prior to the global financial crisis in 2007-2008, Danish banks expanded their lending substantially in response to strong domestic credit demand and a booming housing market. Credit growth far outpaced growth in deposits and, therefore, Danish banks increasingly relied on financing from foreign financial institutions, often in the form of short-term loans and bonds. Leverage ratios were thus soaring and liquidity ratios plummeting, but with abundant liquidity in international money markets profitability was generally high and no Danish banks failed during the boom leading up to financial crisis (Rangvid et al., 2013).

While Danish banks had very limited direct exposure to the U.S. mortgage-backed securities that were the immediate cause of the financial crisis, many of them were adversely affected by the tightening of credit in 2007-2008 (Shin, 2009; Jensen and Johannesen, 2017). At the same time, the Danish housing market was deteriorating and several banks with large exposure to real estate developers failed. The most prominent of these failures were Bank Trelleborg in March 2008 and Roskilde Bank in August 2008.

When Lehman Brothers failed in September 2008 and international credit markets froze, the funding situation of many Danish banks became critical and a law was swiftly adopted that temporarily extended an unlimited government guarantee to all bank liabilities. Only a handful of very minor banks chose not to participate in the program, which became effective on 10 October 2008 and was set to expire on 30 September 2010.

While many governments resorted to outright nationalizations of the most troubled banks (Laeven and Valencia, 2013), the Danish government intervened somewhat more lightly when banks were in distress. In October 2008, the government established a company, "Finansiel Stabilitet", serving to take over the assets and liabilities of failing banks with the aim of a quick resale or liquidation. A few months later, in January 2009, the government offered capital to banks in the form of hybrid core capital, paying a risk premium of 6 percent over the policy rate and being convertible into share capital in the event of distress.

2.2 Government guarantees

In Denmark, similar to the U.S., deposit insurance coverage is determined separately for accounts held by the same individual at different banks, that is, the deposit insurance limit applies on a per-depositor, per-bank basis. This allows depositors to increase effective coverage by holding accounts at multiple banks.

Prior to the financial crisis, bank deposits up to DKK 300,000 were covered by deposit insurance. In October 2008, at roughly the same time as the Danish government extended a temporary guarantee to all bank liabilities, the European Commission proposed to harmonize the level of protection of the ordinary deposit insurance schemes across the EU member states. The European Commission proposal responded to concerns that differing levels of deposit insurance could lead to flight of deposits across borders and threaten the stability of the banking system in countries with relatively low insurance limits. Thus, compliance with the proposal required that Denmark reduce its coverage to a threshold set by the European Commission. A Danish law, adopted in spring 2009, implemented the new European rules by setting the deposit insurance limit to EUR 100,000, approximately DKK 750,000 at the pegged exchange rate, as of 1 October 2010. Note that the European Union determined the threshold and set it to be uniform across all member states; hence, it was exogenous to the Danish banking system and left a substantial portion of deposits in Danish banks uninsured, as discussed below.

On introduction of the DKK 750,000 deposit insurance limit in October 2010, the Danish banking sector was still in crisis. During the period 2008-2010, a total of 30 small and medium-sized Danish banks were taken over by "Finansiel Stabilitet" or absorbed by competing banks after failing to meet the capital requirements of the regulatory authority, and even more banks went out of business voluntarily (Rangvid et al., 2013). Consistent with the notion that banks were still at risk, the media coverage of the new deposit insurance limit emphasized how consumers could protect their savings by splitting deposits across banks, by moving deposits to the largest banks most likely to be bailed out in case of distress, or by withdrawing deposits and investing the funds in other safe assets.[1]

On 6 February 2011, Amagerbanken failed and, unlike in previous failures, the Financial Regulator announced that uninsured depositors would suffer haircuts of around 40%; the first application of a new set of European bail-in rules. This change in policy presumably changed perceptions about implicit guarantees. The event induced Moody's to downgrade the long-term credit ratings of major Danish banks, reflecting a downward revision of the agency's assumptions about systemic support from 'high' to 'low' (Moody's, 2011).[2] Danish media coverage emphasized that deposits in Amagerbanken below DKK 750,000 were safe and that most customers would experience no interruptions in their day-to-day

[1] "Sådan sikrer du dine penge mod bankkrak", TV2, 22 September 2010; "Slut med fuld indskudsgaranti", DR, 30 September 2010.

[2] The long-term rating of two systemic banks, Danske Bank and FIH Erhvervsbank, was downgraded together with three large but non-systemic banks. The long-term rating of three other systemic banks, Nordea, Sydbank and Jyske Bank, were placed on review for a possible downgrade.

business with the bank; but also reported that shares in the bank were most likely worthless and that deposits above DKK 750,000 would be written down by around 40%.[3]

Figure 1 summarizes the key events. The financial crisis starts in Denmark in early 2008 with the first bank failures and heightened uncertainty about the fragility of the banking system, reflected in the increase in the interest rate spread. The blanket guarantee issued at the peak of the crisis quickly eliminated most of the spread; however, bank failures continued to be common in 2010, when the blanket guarantee expired and deposit insurance was capped at DKK 750,000, and in 2011, when the bail-in rules were first applied at the event of Amagerbanken's failure.

Figure 1 around here

3. Data

We obtain information about bank account balances from the records of the Danish tax authorities. At the end of each year, all financial institutions in Denmark report the balance of all deposit accounts held by Danish residents to the Danish tax authorities. The reports are collected for the purpose of tax enforcement and, therefore, are compulsory and reliable. We consolidate the account-level information at the bank-individual level, the relevant level for deposit insurance purposes, by summing accounts held by the same individual in the same bank. For each individual, we thus observe the end-of-year consolidated account balance in each Danish bank for each of the years 2003-2011. To this dataset, we add comprehensive information about individuals from administrative registers (e.g. age, gender and income) as well as balance sheet information about banks from the Danish Central Bank. For computational tractability, we limit the analysis to a 10% random sample of the full adult population.[4]

Figure 2 illustrates the distribution of deposits in 2007 and highlights how the fraction of deposits and accounts that are insured varies with the insurance limit. For each value of X, the blue line shows the value of deposits held on accounts with a balance above X as a fraction of all deposits in the banking system (that is, the numerator is the sum of Y for all accounts with balance Y>X). The red line shows the value of account balances above X as a fraction of all deposits in the banking system (that is, the numerator is the sum of Y-X for all accounts with balance Y>X). Put simply, for a given deposit insurance limit X, the blue line shows the share of deposits in partly uninsured accounts whereas the red

[3] "Amagerbanken er krakket", Politiken, 6 Februar 2011; "Minister lover hjælp til bankkunder efter krak", Politiken, 7 Februar 2011.

[4] Table A1 in the Online Appendix shows that there are no material differences between the 10% estimation sample and the 90% outside the estimation sample.

line shows the share of deposits that is uninsured. The dotted vertical line illustrates the insurance limit of DKK 750,000, introduced in October 2010. We observe that deposits on accounts with a balance above this limit constituted almost 40% of all deposits whereas account balances above the limit constituted more than 20% of all deposits. Hence, if depositors were to withdraw all balances above the insurance limit, banks would lose more than one fifth of all deposits; if they were to liquidate all accounts with some uninsured balances, the loss would be close to two fifths of all deposits.

Figure 2 around here

Table 1 reports summary statistics for a number of bank-level variables. Our sample includes 92 banks: Columns (1)-(2) describe the six largest banks in terms of total assets in 2007 whereas Columns (3)-(4) describe the remaining 86 banks. Motivated by the fact that the financial regulator named precisely six institutions when first drawing up a list of systemically important financial institutions in 2014, we consider the former group as systemic banks and the latter group as non-systemic banks.[5,6] As shown in the bottom of the table, our sample of individuals owned around 656,000 deposit accounts in 2007, of which around 8,000 had balances above DKK 750,000. Systemic banks have a market share of around 70%, both in terms of the total number of accounts and accounts with a balance above DKK 750,000.

Table 1 around here

The table highlights several important differences between systemic and non-systemic banks. Besides being much larger (by construction), systemic banks are also less capitalized (lower equity-asset ratio), slightly more liquid (lower loans-assets ratio) and slightly less profitable (lower return on assets). Moreover, systemic banks have a higher share of deposits on accounts above DKK 750,000 (37% vs 28% in non-systemic banks) and a higher share of deposit balances above DKK 750,000 (23% vs 14% in non-systemic banks).

4. Limiting deposit insurance: reallocation of deposits across accounts

This section documents that the deposit insurance limit introduced in 2010 was associated with a significant reallocation of retail deposits across accounts: depositors responded by splitting deposits above the insurance limit across multiple accounts, but not by withdrawing deposits from the banking system.

[5] Our micro-data are de-identified and we therefore cannot name the six systemic banks in our analysis nor compare with the six institutions officially designated systemically important in 2014.

[6] None of the Danish SIFIs are large enough to be on the global list of systemic banks G-SIB.

4.1 Distribution of deposit balances

Figure 3 illustrates how the account-level distribution of deposits changed when deposit insurance was limited at DKK 750,000 in October 2010. For each year, the histograms show the number of accounts in 1000-DKK bins over a range of account values close to the limit. The distribution is smooth at the end of 2008 and 2009; however, considerable excess mass emerges at 750,000 DKK at the end of 2010 and remains at the end of 2011. This is strongly suggestive that some depositors drew down account balances to the insurance limit to reduce exposure to bank failures. While the annual frequency of the account-level deposit information limits our ability to determine the timing of these responses, there are no signs of anticipatory effects by the end of 2009 despite the deposit insurance limit having been announced already in spring 2009.

Figure 3 around here

The bunching at DKK 750,000 could derive from two distinct types of depositor responses. Depositors either transferred uninsured balances to accounts in other banks or they withdrew uninsured balances from the banking system and invested them in other assets. The distinction is important because the former type of response merely reallocates deposits within the banking system whereas the latter reduces the aggregate value of deposits and may therefore create funding problems for the banking system as a whole.

To help distinguish the two types of responses, we study the individual-level distribution of deposits in the same window and for the same period. If the account-level bunching at the insurance limit reflects reallocations across accounts, the individual-level distribution should exhibit no bunching since such reallocations do not change individual-level deposit totals. Conversely, if the account-level bunching reflects withdrawals from the banking system, we should observe the same bunching in the individual-level distribution. Figure 4 shows that the individual-level distribution of deposit balances is smooth over the entire range both before and after the introduction of the insurance limit. This strongly suggests that the account-level bunching at the limit is driven by deposit reallocations across accounts rather than withdrawals of deposits from the banking system.

Figure 4 around here

4.2 Regression framework

While the emergence of bunching of account balances around DKK 750,000 in 2010 is strongly suggestive of deposit reallocations in response to the insurance, it is important to emphasize that

reallocations of deposits across accounts do not necessarily give rise to bunching at the insurance limit. For instance, in the case of a depositor splitting a DKK 1,000,000 account into two DKK 500,000 accounts we observe no new accounts at DKK 750,000. In order to gauge the full extent of the reallocation of deposits, we consider changes in the wider distribution of account balances in a regression framework.

Our goal is to estimate to what extent the deposit insurance limit introduced in 2010 was associated with a reduction in deposits above the limit (which became uninsured) relative to deposits below the limit (which remained insured). In an account-level regression, we would face the difficulty that any account with a balance above the insurance limit includes deposits that remained insured (balances up to the limit) as well as deposits that became uninsured (balances in excess of the limit). For instance, an account with a balance of DKK 900,000 combines DKK 750,000 that remained insured and DKK 150,000 that became uninsured. For the purposes of the regressions, we therefore slice up each account in a number of deposit ranges, DKK 0-50,000, DKK 50,000-100,000, DKK 100,000-150,000 and so on, and compare, at the bank-level, how deposits in ranges that remained insured evolved relative to deposits in ranges that became uninsured. To be precise, an account with a balance of DKK 900,000 contributes DKK 750,000 to ranges that remain insured and DKK 150,000 to ranges that become uninsured.

Specifically, we estimate the following baseline model for the period 2008-2011:

$$\log(deposits)_{btk} = \alpha + \beta_1 Above_k + \beta_2 After_t + \beta_3 Above_k \times After_t + \gamma X_i + \varepsilon_{btk}$$

The dependent variable is deposits (in logs) in bank *b* in year *t* in range *k*. We include ten ranges of width DKK 50,000 between DKK 500,000 and 999,999, hence the estimation includes ten observations per bank-year. The explanatory variables are: *Above* indicating that the range starts at DKK 750,000 or above; *After* indicating that the year is 2010 or later; and a set of controls capturing bank characteristics in 2007. The key variable is the interaction *After* × *Above* capturing the deposit growth in ranges above the threshold between the pre-reform and the post-reform period relative to the deposit growth in ranges below the threshold over the same period. Since ranges below the threshold are not directly affected by the deposit insurance reform, this can be interpreted as a difference-in-difference estimate of the effect of insurance on deposits in a given range.

Table 2 reports the results from this baseline specification in Column (1). The coefficient on *After* shows that deposits below DKK 750,000 increased by almost 35% from the period 2008-2009 to the period 2010-2011 (i.e., $e^{0.292}$ - 1). Combining this estimate with the coefficient on *After* × *Above* shows that deposits above DKK 750,000 decreased by around 5% (i.e., $e^{0.292 - 0.363}$ - 1). The difference in growth rates

is highly significant and suggestive that the removal of the unlimited deposit insurance had a large effect on the allocation of deposits.

Table 2 around here

To probe the robustness of these results, we sequentially add dummies to the baseline specification. Columns (2) and (3) add bank dummies and bank-range dummies that absorb cross-sectional variation. Column (4) further adds bank-time dummies that absorb all bank-level shocks. This specification controls exhaustively for bank characteristics (including the characteristics of the average customer), both in levels and changes, and effectively identifies from within-bank differences in the growth rate of deposits above and below the limit. The coefficient on the main variable of interest, *After* × *Above*, is almost identical across all specifications.[7]

We also estimate a fully dynamic version of the specification in Column (3) where *After* is replaced by a vector of time dummies (2009 is the omitted category). Figure 5 illustrates the results: deposits above and below DKK 750,000 followed almost identical trends over the period 2006-2009 but then diverged sharply in 2010. Deposits below the threshold continued to increase at roughly the same rate whereas deposits above the threshold decreased rapidly both in absolute and in relative terms. In 2011, deposits below the threshold had increased by around 25% from the level in 2009 whereas deposits above the threshold had decreased by around 25%. Assuming that deposits above the limit would have grown at the same rate as deposits below the limit if deposit insurance had remained unlimited, the estimates imply that limiting insurance caused a 50% decrease in deposits above the limit.[8]

Figure 5 around here

Again, the results illustrated in Figure 5 could reflect reallocations of deposits across accounts *or* withdrawals from the banking system. To distinguish the two types of responses, we repeat the regression with the sole exception that we form the dependent variable by assigning individuals to their primary bank and summing individual-level rather than account-level deposits within each bank and range. To illustrate the difference, consider a depositor holding a single account with a balance of DKK 800,000 who moves DKK 50,000 to a new account in another bank. In the analysis based on account-level values, this triggers a DKK 50,000 decrease in the range DKK 750,000 - 799,999 whereas, in this analysis based

[7] Table A2 in the Appendix shows the same results when the data is collapsed to two time periods: pre-reform (2008-2009) and post-reform (2010-2011).

[8] Figure A1 in the Appendix displays the difference between the estimated trends below and above the insurance limit and the confidence intervals around these difference-in-difference estimates: with a *t*-value of 4.5, we can reject the null hypothesis that deposits below and above the limit grew at the same rate through 2010 and 2011.

on individual-level deposit values, it changes nothing because individual-level deposits remain at DKK 800,000. By contrast, if the depositor withdraws DKK 50,000 from the deposit account and the money does not reappear on other accounts, it triggers a DKK 50,000 decrease in the range DKK 750,000 - 799,999 in both analyses.

As shown in Figure 6, the deposit insurance limit had no discernible effect on individual-level deposit balances: individual-level deposits below and above DKK 750,000 followed almost identical trends throughout the sample period.[9] Together, Figures 5 and 6 confirm the finding in the previous section that the insurance limit caused a significant reallocation of deposits within the banking system but was not associated with a decrease in aggregate deposits.

Figure 6 around here

The figure also highlights the significant overall growth in deposits during the financial crisis: annual growth rates hovered around 10% both above and below the limit in the years 2007-2009. This is consistent with a flight to the relative safety of the banking system as other asset types became more risky (Gatev and Strahan, 2006).

4.3 Splitting of accounts

To reduce account balances above the insurance limit (Figure 5) without reducing their total deposits in the banking system (Figure 6), depositors necessarily must have split deposits across multiple accounts. We provide direct evidence on this mechanism in Figure 7 by showing the fraction of depositors who increased the number of deposit accounts in a given year, grouped by the size of their total deposits. We observe a surge in the splitting of accounts at the onset of the financial crisis in 2008 for all groups holding total deposits above the old insurance limit of DKK 300,000; a drop in 2009 when all deposits were explicitly guaranteed by the government; and a surge again in 2010 for groups holding total deposits above the new insurance limit of DKK 750,000.

Figure 7 around here

[9] Figure A2 in the Appendix displays the difference between the estimated trends below and above the insurance limit and the confidence intervals around these difference-in-difference estimates: the differential change above the limit is far from statistical significance.

5. Too-Big-To-Fail: reallocation of deposits across banks

This section shows that the reallocation of deposits across accounts in response to the insurance limit was also associated with a reallocation of deposits across banks: even as systemic banks lowered interest rates on large deposits relative to non-systemic banks, they were more successful at retaining and attracting deposits above the insurance limit. The results are suggestive that the implicit government guarantee of banks that are too-big-to-fail distorted competition for retail deposits.

5.1 Distribution of deposit balances

Figure 8 illustrates how the account-level distribution of deposits changed differentially for systemic and non-systemic banks when deposit insurance was limited at DKK 750,000 in October 2010. It is comparable to Figure 3 except that we express the number of accounts in each 1000-DKK bin as a fraction of all accounts with a balance above DKK 100,000 to facilitate comparison between systemic and non-systemic banks. In 2008 and 2009, the distributions are very similar for systemic and non-systemic banks and, consistent with the evidence in Section 4.1, there is no bunching at any account value. In 2010, clear bunching emerges at DKK 750,000, but only in non-systemic banks: the fraction of accounts in non-systemic banks with a balance exactly at the new insurance limit increases by around 700% between 2009 and 2010 with no corresponding increase in systemic banks.

Figure 8 around here

The finding that depositors in non-systemic banks drew deposit balances down to the insurance limit much more frequently than depositors in systemic banks represents our first suggestive evidence that implicit guarantees to systemic banks distort the competitive landscape. The results are consistent with depositor beliefs that deposits in systemic banks are safe, even if not covered by explicit guarantees, because banks with systemic importance are bailed out with a high probability in case of distress.

5.2 Deposit quantities

To explore further the role of implicit guarantees, we estimate the fully dynamic model of account-level responses (analogous to Figure 5) while allowing for differential time paths for systemic and non-systemic banks. The regression thus includes four terms - *Above×Systemic, Below×Systemic, Above×Nonsystemic* and *Below×Nonsystemic* – each of which is interacted with a vector of year dummies. As shown in Figure 9, deposits in all four categories, above and below the limit in systemic and non-systemic banks, followed roughly similar trends over the period 2006-2009. After the deposit insurance reform, deposits below the threshold continued to grow at roughly the same rate as before the reform in both systemic and non-

systemic banks, increasing by around 25% through 2010 and 2011. By contrast, deposits above the threshold diverged sharply from the pre-reform trend in non-systemic banks, with a decrease of around 30% through 2010 and 2011, but much less so in systemic banks, where there was a slight absolute increase over the same period. The resulting difference-in-difference estimates suggest that limiting deposit insurance caused deposits above the limit to decrease by more than 50% in non-systemic banks, but only by slightly more than 20% in systemic banks.[10]

Figure 9 around here

To probe the robustness of the finding that banks' systemic importance is a key determinant of depositor responses to the insurance limit, we conduct four additional tests.

First, one may be concerned that the divergence between systemic and non-systemic banks evidenced in Figure 9 is driven by other bank characteristics possessed disproportionately by systemic banks. To address this concern, we test whether the decrease in deposits above the limit remains significantly different for systemic and non-systemic banks when the decrease is also allowed to vary with other bank characteristics. Concretely, we estimate the most saturated version of the baseline model (with bank-time dummies) where *After* × *Above* is interacted with a dummy for being systemic, but also with dummies capturing three other possible determinants of depositor responses to the insurance limit: high capitalization, high liquidity and high profitability.

Columns (1)-(2) in Table 3 show that high capitalization, high liquidity and high profitability tend to reduce the loss of deposits above the insurance threshold after the introduction of the insurance limit, possibly because these characteristics are associated with a lower perceived risk of failure. However, the estimated effect of being a systemic bank barely changes when we account for these other characteristics. Specifically, on the margin, a ratio of equity to assets above the median raises the negative difference-in-difference estimate by 0.17 log points, a ratio of loans to assets below the median raises it by 0.14 log points and a return on assets above the median raises it by 0.05 log points. However, the marginal effect of being a systemic bank remains highly significant and increases slightly when these factors are included in the model.

Table 3 around here

[10] Figure A3 in the Appendix shows that both difference-in-difference estimates are statistically significant and so is the difference between them: with a *t*-value of 4.8, we can reject the null hypothesis that systemic and non-systemic banks experienced the same decrease in deposits above the limit relative to deposits below the limit.

Second, it is conceivable that the divergence between systemic and non-systemic banks owes itself to differences in customer characteristics: it is possible that non-systemic banks have customer types, for instance more risk-averse types, who respond more strongly to the loss of deposit insurance. This is effectively an interaction effect between customer characteristics (i.e., risk aversion) and the account-level balance (i.e., balance above the limit), which is not absorbed by the bank-year fixed effects. We address this concern by augmenting the model with interactions between *After* × *Above* and observed customer characteristics: gender, age and income.

Columns (3)-(4) show that all three customer characteristics have a significant effect on the loss of deposits above the limit: having customers older than the median raises the negative difference-in-difference estimate by 0.21 log points, having more female customers than the median raises it by 0.18 log points and having higher-income customers than the median reduces it by 0.18 log points (based on the estimates in Column 3). However, the marginal effect of being a systemic bank remains highly significant and is of a similar magnitude as in the baseline model.

Third, the striking difference between systemic and non-systemic banks could be due a perception among depositors that large banks are better managed and thus less likely to encounter financial difficulties than small banks regardless of any TBTF guarantees. This could be true if economies of scale allow larger banks to develop superior risk management practices that lower earnings volatility and exposure to losses.

We investigate this alternative explanation by estimating depositor responses to the insurance limit for each of 15 small groups of similarly-sized banks. Specifically, we estimate the most saturated variant of the baseline specification (Column (4) in Table 2) augmented with interactions between *After* × *Above* and dummies indicating the size group (one dummy for the six largest banks in 2007, another dummy for the next six banks in the size distribution and so on).[11] The group with the six largest banks corresponds to our definition of systemic banks.

The 15 group-specific coefficients on *After* × *Above*, plotted against bank size in Figure 10, provide evidence of a highly non-linear relationship with the systemic banks standing out as a clear outlier. As shown in the figure, regressing the estimated coefficients on size within the sample of non-systemic banks yields a negative gradient with predicted coefficients around -0.3 for the smallest banks and around -0.5 for the largest non-systemic banks. However, the estimated coefficient for systemic banks is very far from the extrapolated regression line with a coefficient around -0.2. This suggests that depositors considered

[11] For confidentiality reasons, we cannot show estimates for individual banks or very small groups of banks.

systemic banks to be safer than other banks and in particular much safer than large non-systemic banks. The most natural interpretation is that systemic banks enjoyed more generous implicit bailout guarantees than non-systemic banks.[12]

Figure 10 around here

We provide a more formal test by comparing systemic and non-systemic banks within the sample of the 12 largest banks. While the six systemic banks are considerably larger than the following six non-systemic banks, the latter are almost certainly large enough to exhaust the economies of scale (Wheelock and Wilson, 2001). It is therefore much less likely that there are qualitative differences in management practices within this smaller sample of large banks than within the full sample of banks. Column (5) in Table 3 shows that the difference between systemic and non-systemic banks widens when the sample is restricted to the 12 largest banks. This is consistent with the notion that the muted responses by uninsured depositors in systemic banks owe themselves to implicit bailout guarantees, but is difficult to reconcile with the alternative explanation highlighting better risk management practices and lower probability of distress.

Fourth, acknowledging that there is no perfect delineation of systemic and non-systemic banks, and that reallocations of deposits are ultimately shaped by (possibly heterogeneous) depositor perceptions of bank safety, we explore to what extent our results are sensitive to the threshold at which systemic and non-systemic banks are delineated. Columns (6)-(9) in Table 3 show that the difference between systemic and non-systemic banks is larger when systemic banks are defined as the largest four or five banks and smaller when defined as the largest seven or eight banks, but strongly significant in any of these cases. These results are consistent with depositors holding heterogeneous beliefs about whether the handful of banks just below the top-3 are too-big-to-fail and with the fraction of depositors believing that a bank is too-big-to-fail an increasing function of bank size.[13]

Finally, we provide evidence on the mechanisms underlying the differential losses of uninsured deposits in systemic and non-systemic banks. In Columns (10)-(11), we show that the same qualitative result emerges when we only consider *new accounts*, those opened by depositors in the course of the year, and *existing accounts*, those that existed already at the beginning of the year: systemic banks were more

[12] The standard errors of the point estimates are reported in Figure A4 in the Appendix

[13] As a final robustness test, we check whether the divergence between systemic and non-systemic banks in 2010 could be due to pre-existing differences in the account-level distribution of deposits. Figures A5-A6 in the Appendix show that the two groups of banks had almost identical deposit distributions before 2010, but very different distributions after.

successful at attracting as well as retaining uninsured deposits. Intuitively, the effect of the insurance limit is much stronger for new accounts than for existing accounts in both types of banks.[14]

5.3 Deposit prices

After studying how deposit quantities changed differentially around the deposit insurance reform, we now turn to deposit prices. We note that differential changes in interest rates could potentially explain the differential changes in deposits. It is possible that systemic banks suffered smaller losses of uninsured deposit balances because they raised interest rates relative to other banks. Yet, it would be problematic to include prices as controls in the regressions concerning quantities because they are themselves endogenous to withdrawals of uninsured deposits. Conceptually, we therefore treat deposit prices as outcomes that are determined jointly with deposit quantities.

Since we do not observe interest rates directly in the micro-data, we first need to impute them from information about interest payments and account balances. Specifically, we impute account-level interest rates in the following way:

$$interest\ rate_{ibt} = \frac{interest\ received_{ibt}}{average\ account\ balance_{ibt}}$$

where *i* refers to the individual, *b* to the bank and *t* to the year. We only observe account balances at the end of each year and therefore use the average balance at the end of year *t* and the end of year *t-1* as a proxy for the average account balance over year *t*. As the proxy is less prone to measurement error when the account balance is roughly stable within the year, we choose to consider only account-years with a change in the balance of less than 20%.[15] In the Appendix, we document that the imputation delivers economically meaningful interest rates: the distribution of imputed interest rates has a mode around 2 percent and very little mass above 6 percent (Figure A7); and the within-year median exhibits roughly the

[14] To be specific, new deposits above DKK 750,000 decreased by more than 60% (i.e., $e^{-0.976} - 1$) relative to new deposits below in non-systemic banks and by 40% (i.e., $e^{-0.976 + 0.473} - 1$) in systemic banks. The decrease in existing deposits above DKK 750,000 relative to existing deposits below was slightly more than 25% (i.e. $e^{-0.319} - 1$) in non-systemic banks and around 10% (i.e., $e^{-0.319+0.211} - 1$) in systemic banks.

[15] If, for instance, the balance is DKK 250,000 at the end of year *t-1* and the owner made a single transfer of DKK 500,000 to the account during year *t* to bring the balance at the end of year *t* to DKK 750,000, our proxy for the average account balance is DKK 500,000. However, the true average balance may be close to DKK 250,000 if the transfer happened in early January or close to DKK 750,000 if the transfer happened in late December. If interest over year *t* amounts to DKK 10,000, the imputed interest rate is 2 percent; however, the true interest rate may range between 1.3 and 4 percent depending on the timing of the transfer. Clearly, this type of noise is larger the more the account balance changes over the year.

same trend over time as the government bond rate (Figure A8). Equipped with this measure, we explore the effects of the deposit insurance limit on interest rates.

In a first step, we estimate the differential change in interest rates around the introduction of the deposit insurance limit in non-systemic banks relative to systemic banks. To distinguish the general trend in interest rates from the interest rates on deposits that became uninsured, we provide specific estimates for different ranges of account values by estimating the following model:

$$interest\,rate_{btk} = \alpha + \beta_{1k} Nonsystemic + \beta_{2k} After_t + \beta_{3k} Nonsystemic_k \times After_t + \varepsilon_{btk}$$

where the dependent variable is the median imputed interest rate among all the accounts in bank *b* in year *t* in range *k*. The key parameters of interest are the difference-in-difference estimates β_{3k} which express the interest rates change in range k from 2008-2009 to 2010-2011 for non-systemic relative to systemic banks.

As shown in Figure 11, the point estimates are positive in all ranges, but clearly increasing in account size: less than 0.2 percentage points (and statistically insignificant) for accounts below the insurance limit, increasing to more than 0.5 percentage points (and statistically significant) for large accounts above DKK 1,500,000. The results are suggestive that non-systemic banks differentially raised the interest rate premium to deposit balances above DKK 750,000. This interpretation is consistent with the finding that the differential change in interest rates is zero for accounts below the insurance limit and increasing in the deposit share above the insurance limit.

Figure 11 around here

To verify that the differential increase in interest rates on large accounts is not driven by differential underlying trends, we also estimate a dynamic version of the model where *Systemic* and *Nonsystemic* are interacted with a full vector of time dummies for accounts larger than DKK 1,000,000. To abstract from the large swings in market interest rates over the estimation period, we use the difference between deposit rates and government bond rates as our outcome.[16] Figure 12 illustrates the results: deposit rates increased steeply relative to the bond rates over the period 2006-2009, perhaps reflecting increased competition for retail deposits as other funding sources became scarcer, but both the absolute level and the trend over time were strikingly similar across systemic and non-systemic banks. However, coinciding with the

[16] Note that subtracting the same constant for all observations in the same year changes the estimated trends for systemic and non-systemic banks, but not the difference between them.

deposit insurance limit in 2010, there are clear signs of divergence with interest rates in systemic banks decreasing by around 0.4 percentage points relative to non-systemic banks.[17]

Figure 12 around here

We run the same model for accounts between DKK 500,000 and DKK 750,000 that remained insured throughout the period and show the results in the Appendix. Also in this range, interest rates on deposits generally increased relative to bond rates until 2009 and then decreased through 2011; however, consistent with the evidence in Figure 11, there is no sign of divergence between systemic and non-systemic banks in 2010 (Figures A10-A11 in the Appendix). By implication, the difference between interest rates on uninsured accounts and insured accounts followed a similar trend in systemic and non-systemic banks until 2009 and then diverged in 2010 (Figures A12-A13 in the Appendix).

While the previous section showed that systemic banks retained and attracted more deposits above the insurance limit introduced in 2010, the results in this section show that this happened even as systemic banks differentially lowered interest rates on such deposits.

5.4 The timing of depositor responses

A key limitation of the administrative account-level data is the annual frequency. While the coverage of the dataset, all deposit accounts in Danish banks, makes it uniquely suited to study deposit reallocations, the low frequency limits our ability to determine the precise timing of depositor responses. This is important for several reasons. First, the DKK 750,000 deposit insurance limit was announced in spring 2009 and introduced in October 2010, leaving time for important anticipation effects. However, the annual data only allow us to test for anticipation responses as of December 2009. Second, the first application of the bail-in rules in February 2011 may have had a significant impact on depositor beliefs about bank safety, but the annual frequency does not allows us to disentangle the effects of the insurance limit and the bail-in rules. Third, it is possible that the depositor responses estimated at the annual frequency conceal even larger responses at higher frequencies, such as short-lived panics around shifts in depositor beliefs about government guarantees.

We address these shortcomings using bank-level information on time deposits at the monthly frequency. The dataset derives from the Danish Central Bank and covers around 20 large banks that account for

[17] Figure A9 in the Appendix displays the difference between the estimated trends for systemic and non-systemic banks and the confidence intervals around the differences: interest rates are significantly different in both 2010 and 2011 but not before.

more than 90 percent of all lending (Danmarks Nationalbank, 2013). While the monthly dataset does not distinguish time deposits above and below the insurance limit, time deposits are often savings accounts with a relatively large balance suggesting that it can serve as a proxy for uninsured deposits. Indeed, regressing the share of time deposits in total deposits (retrieved from the bank-level monthly dataset) on the share of deposits above DKK 750,000 in total deposits (derived from the account-level annual dataset) yields a highly significant coefficient of 0.65 and an R-squared of 0.40.

Figure 13 illustrates the results of a simple fixed effects regression with time deposits (in logs) as the dependent variable and a set of time dummies interacted with dummies for systemic and non-systemic banks as independent variables. Time deposits in systemic and non-systemic banks followed very similar trends until June 2010, but then dropped sharply in non-systemic banks until December 2010 while increasing slightly in systemic banks. At the failure of Amagerbanken in February 2011, when bail-in rules were applied for the first time, there was a small decrease in time deposits in both systemic and non-systemic banks; however, the gap that opened up around the deposit insurance reform remains roughly constant throughout the sample period.[18]

Figure 13 around here

While the analysis of monthly bank-level data is less clean than the main analysis of annual account-level data - it relies on cross-bank comparisons of growth rates in time deposits rather than more precise within-bank comparisons of deposits above and below the insurance limit - it is informative about the questions raised above. Specifically, it is suggestive that there were important anticipation responses to the deposit insurance limit starting a few months before its introduction; that the disproportional loss of uninsured deposits by non-systemic banks owes itself to the deposit insurance limit rather than the bail-in rules; and that the annual frequency of the account-level data is unlikely to conceal large losses of deposit above the insurance limit in short-lived panics (although the monthly frequency does not allow us to detect daily or weekly swings in deposit quantities).

6. Pass-through of deposit shocks to bank lending

The results presented above imply that the deposit insurance limit caused a large reallocation of deposits, from accounts above the limit to accounts below and from non-systemic to systemic banks. In this section, we test whether the shock to bank funding passed through to bank lending. For identification,

[18] Figure A14 in the Appendix displays the difference between the estimated trends for systemic and non-systemic banks and the confidence intervals around these difference-in-difference estimates.

we exploit that the funding shock was heterogeneous: banks with a larger share of deposits above the insurance limit were more exposed to the reallocation of deposits across accounts.

We first estimate a simple cross-sectional equation that relates the percentage change in total lending over the period 2007-2011 to the share of deposits over DKK 750,000 in 2007. Importantly, in light of the results indicating that systemic banks were much less exposed to the reallocation of uninsured deposits than non-systemic banks, we adopt a specification that allows the effect to vary flexibly across the two types of banks.

As shown in Table 4, a higher share of deposits over DKK 750,000 in 2007 was associated with a significantly lower growth in lending over the period 2007-2011 for non-systemic banks. Consistent with the previous results that systemic banks were less affected by reallocations of uninsured deposits, we find a much smaller and insignificant effect on lending for this group.[19] For non-systemic banks, the point estimate in Column (1) implies that banks with a share of deposits above DKK 750,000 at the 75th percentile (a share of around 20%) experienced a lending growth that was around 8 percentage points lower than banks at the 25th percentile (a share of around 6%).[20] This result continues to hold when we introduce controls for other bank characteristics in Column (2).

To estimate the structural parameter of interest, the elasticity of lending with respect to deposits, we employ an instrumental variables framework. Specifically, we estimate the effect of growth in deposits over the period 2007-2011, instrumented with the share of deposits over DKK 750,000 in 2007, on the growth in lending over the same period. We focus on non-systemic banks since we do not have an instrument for deposit growth in systemic banks. As shown in Columns (3)-(4), the share of deposits over DKK 750,000 in 2007 is a strong predictor of subsequent growth in total deposits (first stage). As shown in Columns (5)-(6), a one percent drop in deposits due to reallocations of uninsured accounts is associated with a drop in lending of around 0.35 percent (second stage).

7. Conclusion

We study how implicit government guarantees in the form of too-big-to-fail status create distortions on the market for retail deposits. We first document that the introduction of an insurance limit caused a significant reallocation of deposits across accounts, without changing the total value of deposits in the banking system. Deposits above the new insurance limit decreased by around 50% relative to deposits

[19] Note, however, that precision is low due to the very small number of observations identifying this coefficient.
[20] We are not allowed to report the exact percentiles for confidentiality reasons. The average share of deposits above DKK 750,000 is 6.45% for the 5 banks around the 25th percentile and 19.55% for the 5 banks around 75th percentile.

below the limit, but depositors with total balances above the limit did not reduce their total balances relative to depositors with total balances below the limit. We then show that the reallocation of deposits across accounts was associated with a reallocation of deposits across banks: systemic banks were much more successful at retaining and attracting uninsured deposits than non-systemic banks, even as they differentially reduced the interest rate on uninsured deposits. The results show that, in a crisis, too-big-to-fail banks have a major competitive advantage on the market for retail deposits.

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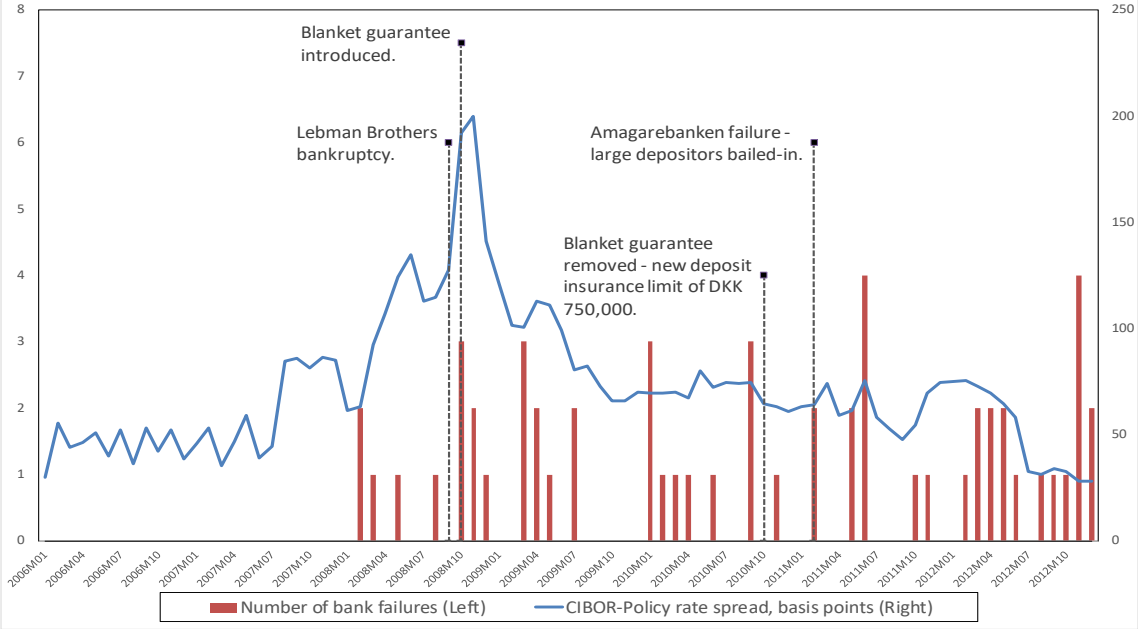
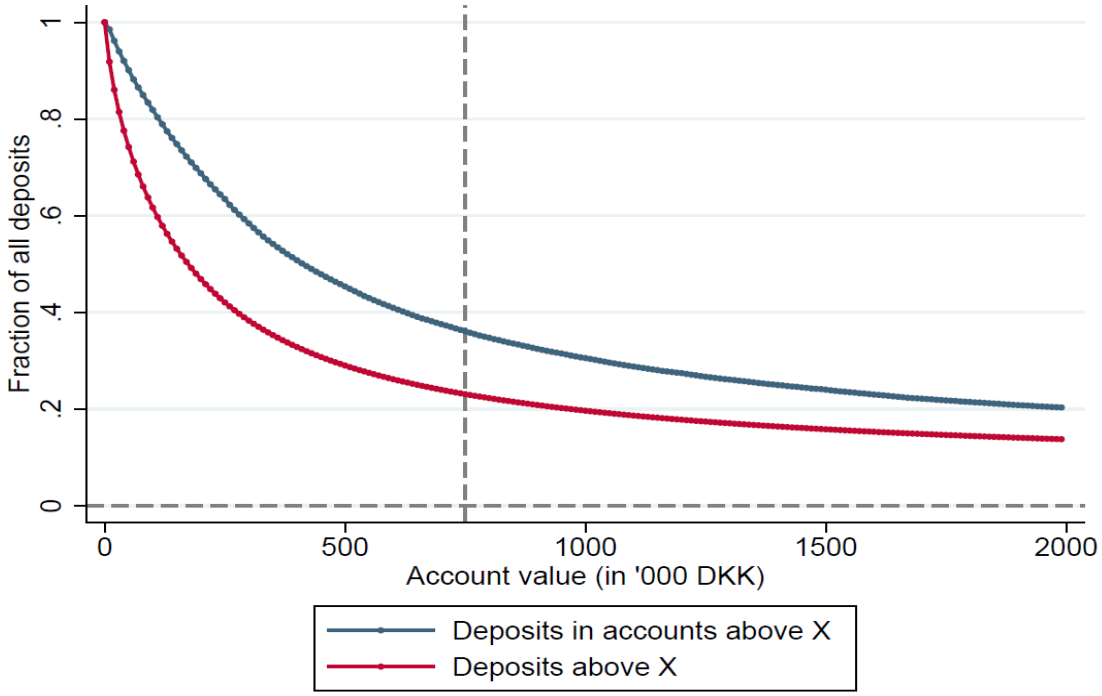
Figure 1: Time line of events



Notes: The figure shows for each month the number of Danish banks (red bars - left axis), the spread between the Danish interbank interest rate (CIBOR) and the policy rate (blue curve - right axis) as well as major events related to depositor perceptions of bank safety.

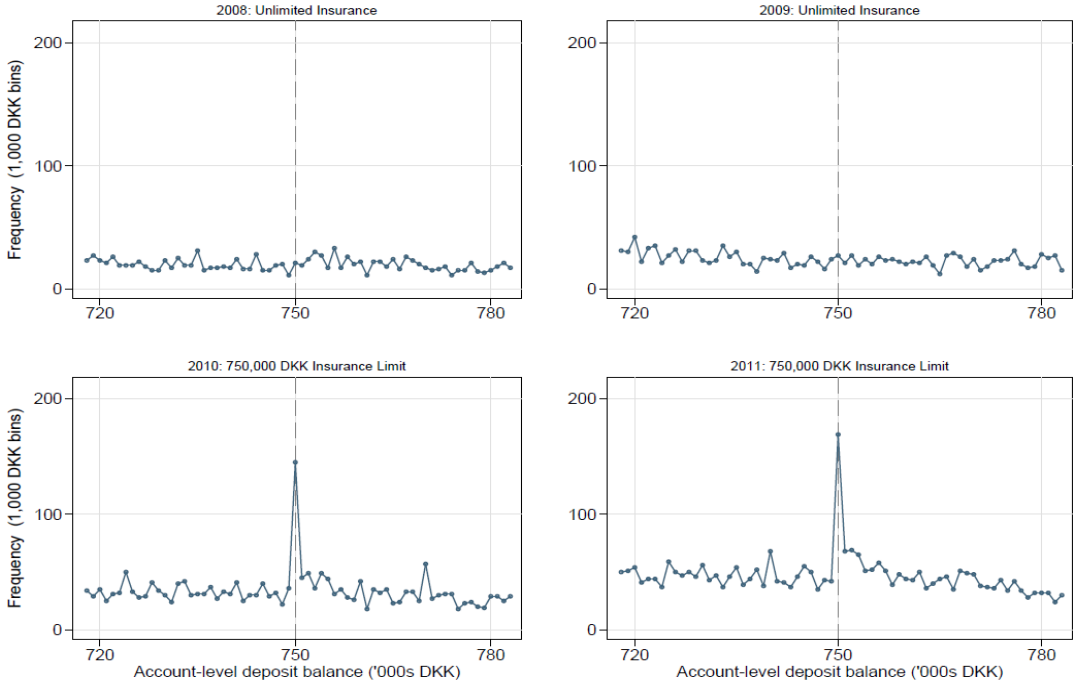
Source: The number of bank failures are from Rangvid et al. (2013). Interest rates are from Statistics Denmark.

Figure 2: Deposits affected by the deposit insurance limit



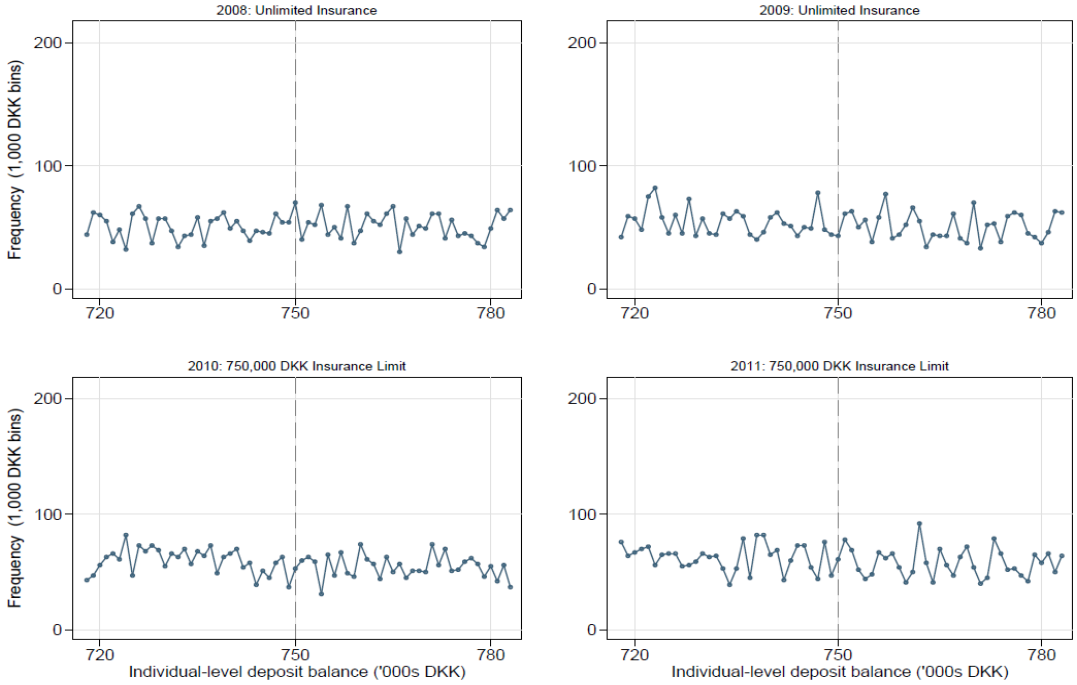
Notes : Based on the account-level distribution of deposits in 2007, the figure shows for each account value X, the fraction of all deposits held on accounts with a balance above X (blue line) and the fraction of deposit balances above X (red line). The dashed line indicates the insurance limit of DKK 750,000 introduced in 2010.

Figure 3: Account-level distribution of deposits around DKK 750,000



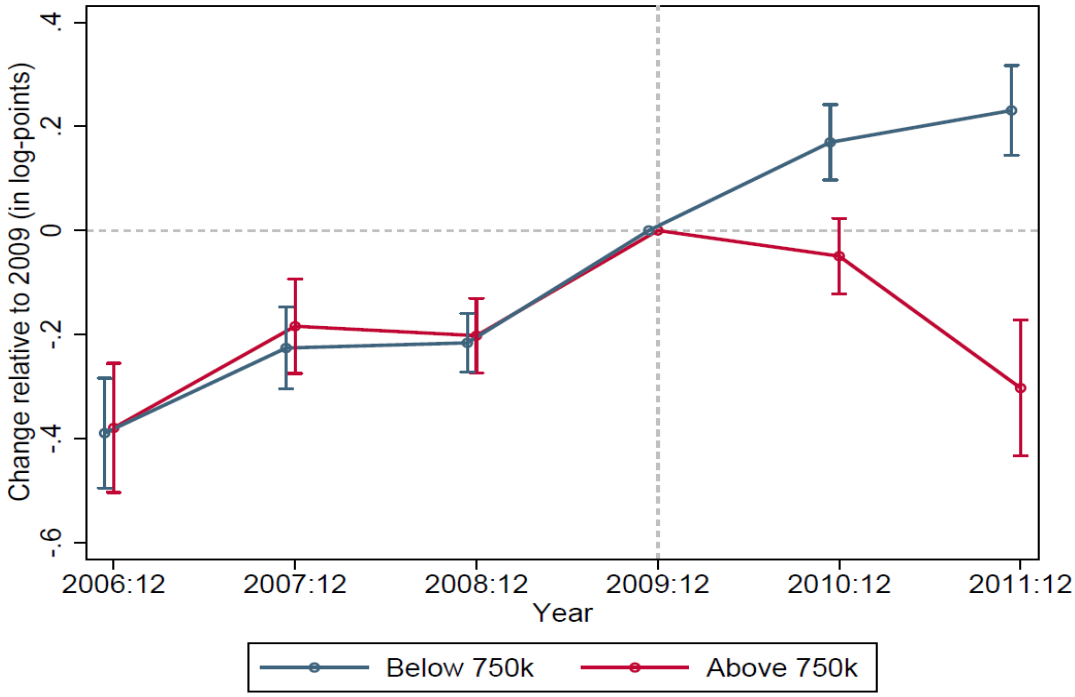
Notes : The figure shows the empirical distribution of account-level deposit balances in a narrow window around DKK 750,000 for each of the years 2008-2009 (where all deposits were guaranteed by the government) and for 2010-2011 (where the insurance limit was DKK 750,000). The sample is divided into DKK 1,000 (approximately USD 150) bins and counts are recorded for each bin. Thus, each point indicates the number of deposit accounts with balances within DKK 500 of the stated amount.

Figure 4: Individual-level distribution of deposits around DKK 750,000



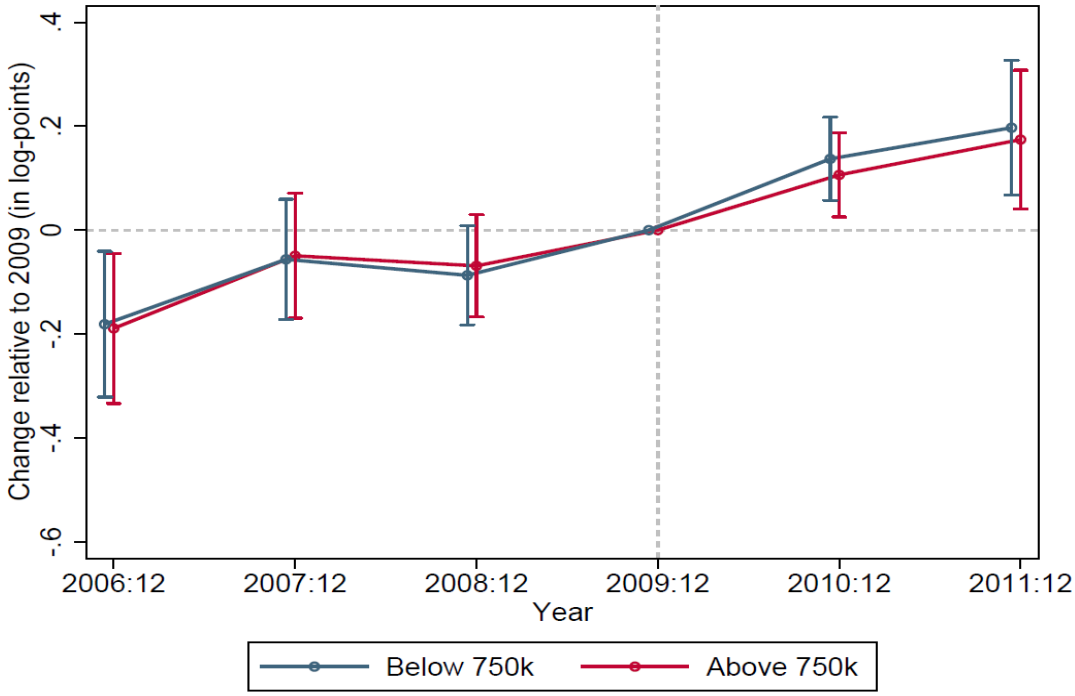
Notes: The figure shows the empirical distribution of individual-level deposit balances in a narrow window around DKK 750,000 for each of the years 2008-2009 (where all deposits were guaranteed by the government) and for 2010-2011 (where the insurance limit was DKK 750,000). The sample is divided into DKK 1,000 (approximately USD 150) bins and counts are recorded for each bin. Thus, each point indicates the number of individuals with total deposit balances within DKK 500 of the stated amount.

Figure 5: Account-level deposits above and below DKK 750,000



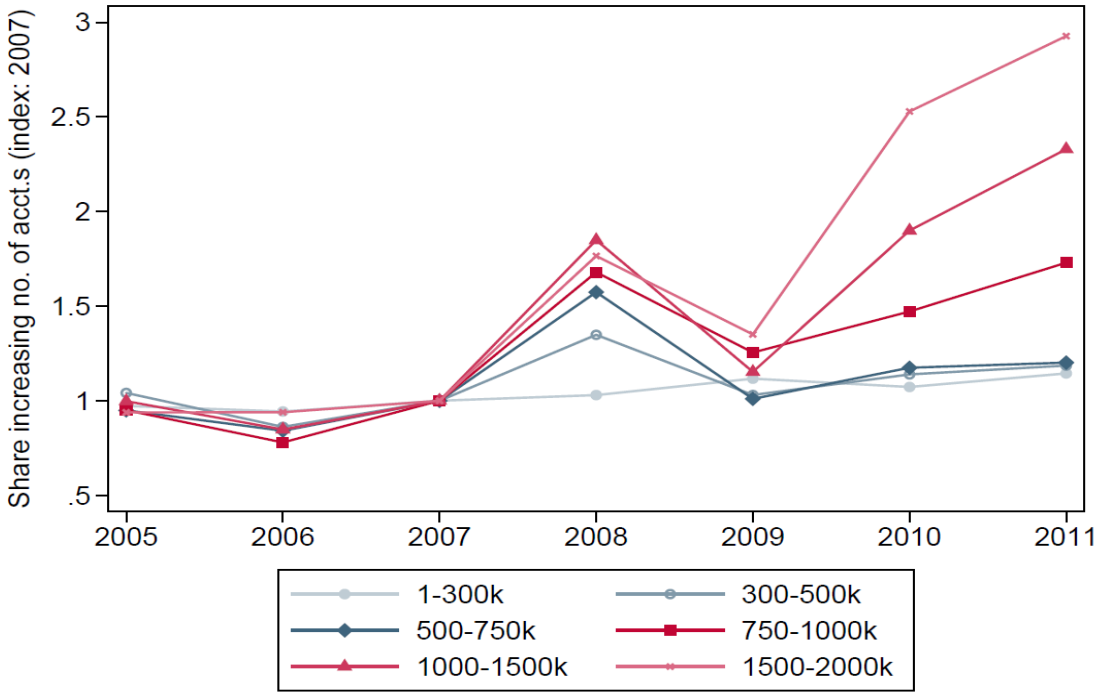
Notes : The figure illustrates the results from an ordinary least squares regression. The dependent variable is deposits (in logs) at the bank-range level summing over account-level balances for accounts held in a given bank and falling in a given range. We use ten DKK 50,000 ranges over the interval DKK 500,000 – 1,000,000. The explanatory variables are a set of bank-range fixed effects, a set of year dummies interacted with indicators that the range is below and above DKK 750,000 respectively (where 2009 is the omitted time category). The figure shows the point estimates on the interaction terms and 95% confidence intervals based on standard errors clustered at the bank-level. The two lines thus indicate the average trend in account-level deposits below (blue) and above (red) the insurance limit relative to the level in 2009. The resulting difference-in-difference estimators are reported in Figure A1 in the Appendix.

Figure 6: Individual-level deposits above and below DKK 750,000



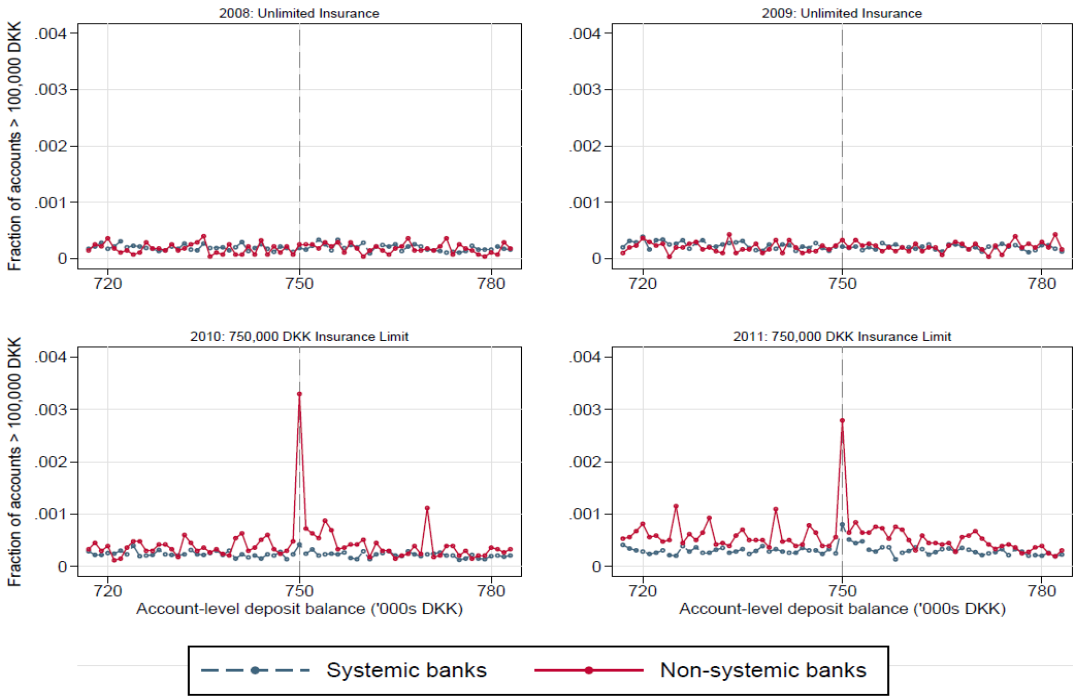
Notes : The figure illustrates the results from an ordinary least squares regression. The dependent variable is deposits (in logs) at the bank-range level summing over individual-level total deposits for individuals who use a given bank as primary bank and have total deposits fall in a given range. We use ten DKK 50,000 ranges over the interval DKK 500,000 – 1,000,000. The explanatory variables are a set of bank-range fixed effects, a set of year dummies interacted with indicators that the range is below and above DKK 750,000 respectively (where 2009 is the omitted time category). The figure shows the point estimates on the interaction and 95% confidence intervals based on standard errors clustered at the bank-level. The two lines thus indicate the average trend in individual-level deposits for individuals with total deposits below (blue) and above (red) the insurance limit (relative to the level in 2009). The resulting difference-in-difference estimators are reported in Figure A2 in the Appendix.

Figure 7: Depositors increasing the number of accounts



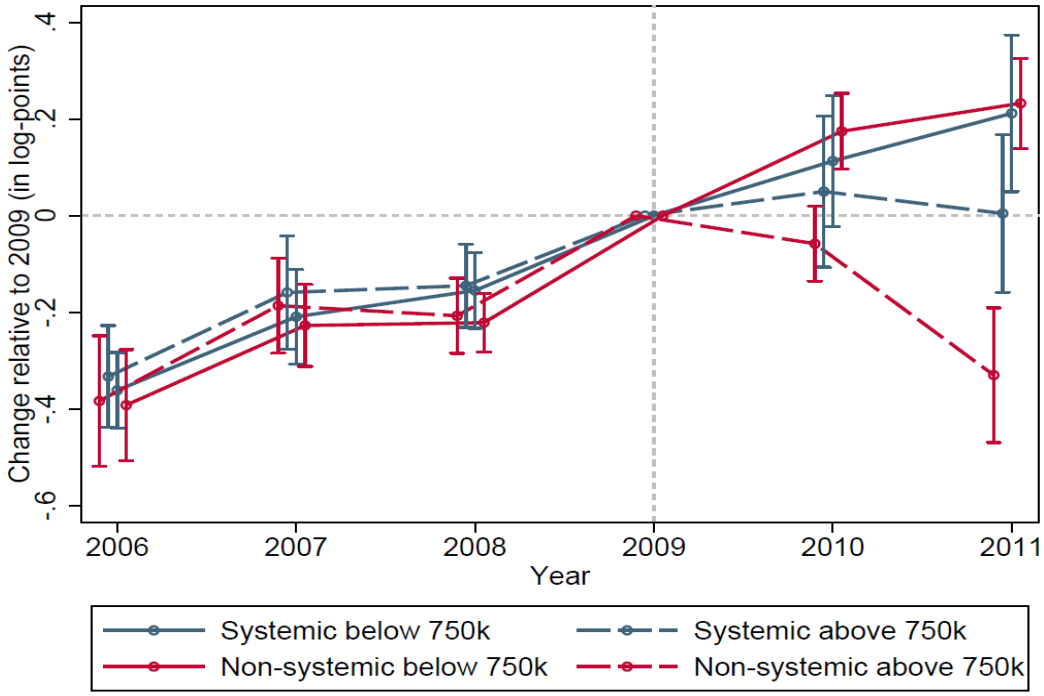
Notes : The figure shows the fraction of depositors increasing the number of accounts for different ranges of total deposits across all accounts. All fractions are measured relative to 2007.

Figure 8: Account-level distribution of deposits around DKK 750,000, by systemic importance



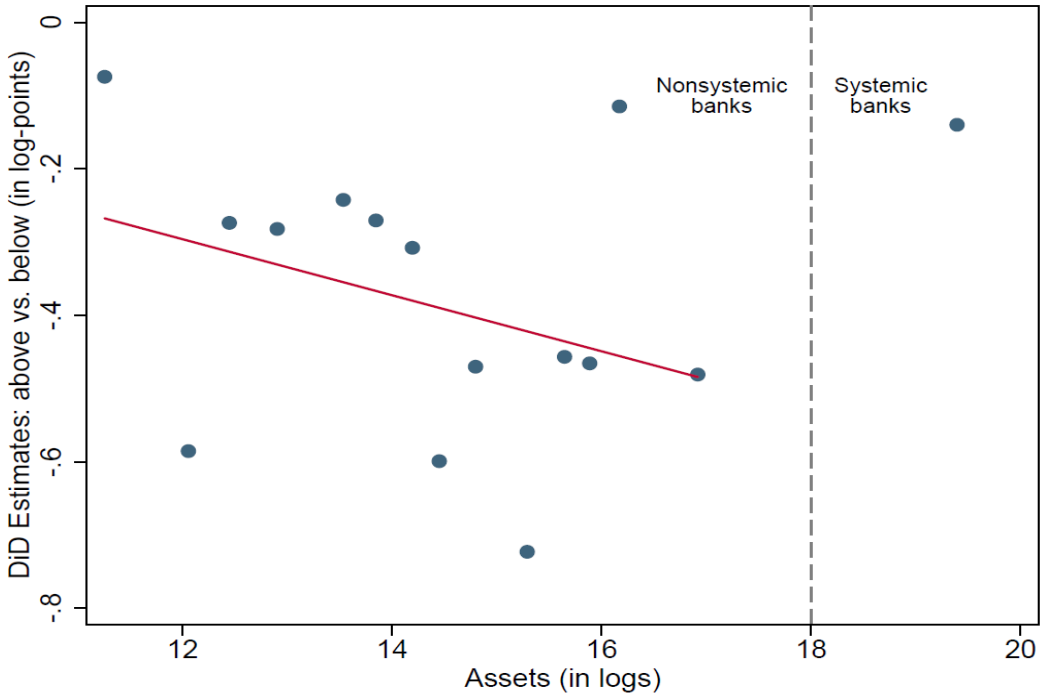
Notes: The figure shows the empirical distribution of account balances in a narrow window around DKK 750,000 for each of the years 2008-2009 (where all deposits were guaranteed by the government) and for 2010-2011 (where the insurance limit was DKK 750,000) for systemic and non-systemic banks separately. Densities are measured relative to the total number of accounts with a balance above DKK 100,000 to facilitate comparisons between the two groups. Systemic banks are the 6 largest banks by total assets in 2007. Non-systemic banks are the remaining 86 banks in the sample. The sample of deposit accounts is divided into DKK 1,000 (approximately USD 150) bins and counts of account balances are recorded for each bin. Thus, each point indicates the number of deposit accounts with balances within DKK 500 of the stated amount.

Figure 9: Deposits in systemic and non-systemic banks



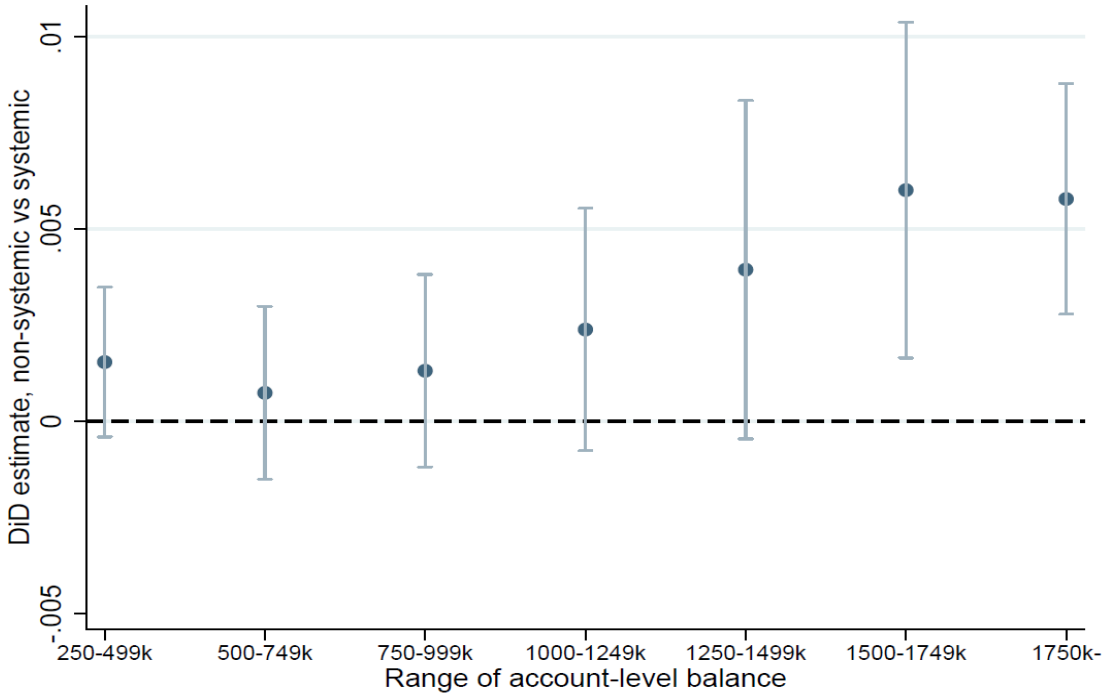
Notes : The figure illustrates the results from an ordinary least squares regression. The dependent variable is deposits (in logs) at the bank-range level (ten DKK 50,000 ranges over the interval DKK 500,000 – 1,000,000). The explanatory variables are a set of bank-range fixed effects and a set of year dummies interacted (where 2009 is the omitted category) with four separate dummies: (i) a dummy indicating that the range is below DKK 750,000 and the bank is systemic; (i) a dummy indicating that the range is above DKK 750,000 and the bank is systemic; (i) a dummy indicating that the range is below DKK 750,000 and the bank is non-systemic; (iv) a dummy indicating that the range is above DKK 750,000 and the bank is non-systemic. The figure shows the point estimates on the triple interaction terms and 95% confidence intervals based on standard errors clustered at the bank-level. The four lines thus indicate the average trend in deposits below (full line) and above (dashed) the insurance threshold in systemic (blue) and non-systemic (red) banks relative to the level in 2009. The resulting difference-in-difference and difference-in-difference-in-differences estimators are reported in Figure A3 in the Appendix.

Figure 10: Difference-in-difference estimates by bank size



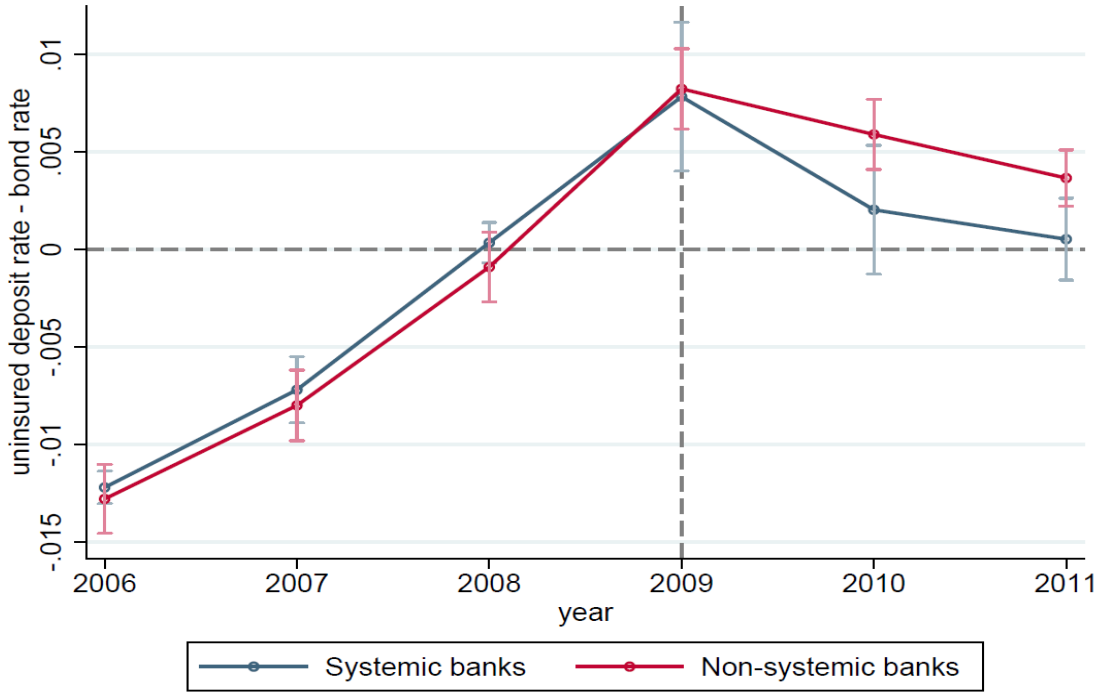
Notes : The figure illustrates the results from an ordinary least squares regression. The dependent variable is deposits (in logs) at the bank-range level (ten DKK 50,000 ranges over the interval DKK 500,000 – 1,000,000). The explanatory variables are a set of bank-range fixed effects, a set of bank-time fixed effects and a set of triple interactions between (i) a dummy indicating that the year is 2010 or 2011 (*After reform*); (ii) a dummy indicating that the range is above DKK 750,000 (*Above Limit*); and (iii) a set of dummies indicating bank size measured in terms of total assets. Specifically, we include 15 bank size dummies corresponding to 15 groups with 6 banks each. The triple interactions represent size-specific difference-in-difference estimates of the effect of the insurance limit on deposits over the limit. The blue dots plot the point estimates on the triple interactions against the (average) size of the banks in the group. The red line is the best linear fit through the blue dots except the one corresponding to the largest six (systemic) banks. Standard errors are reported in Figure A4 in the Appendix.

Figure 11: Interest rates, DiD estimates, non-systemic vs systemic, by account balance



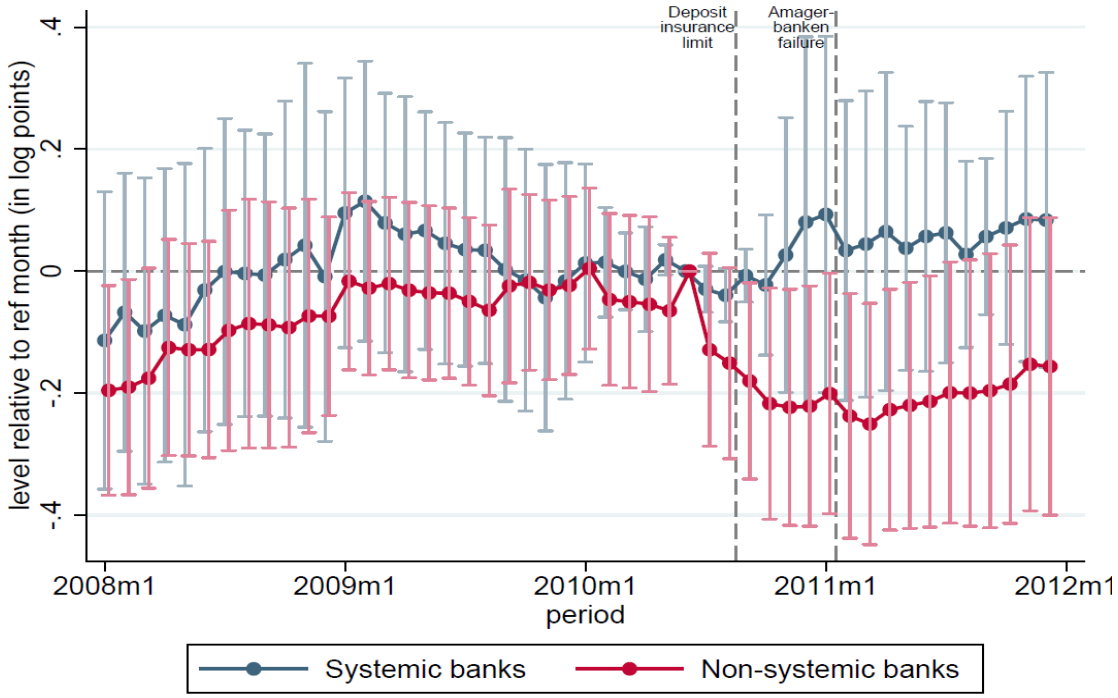
Notes : The figure illustrates the results from a series of ordinary least squares regressions. The dependent variable is the bank-specific imputed interest rate in a given range of deposit balances. The explanatory variables are a set of year dummies, an indicator that the bank is non-systemic interacted with an indicator that the year is 2010 or 2011. The regressions are conducted at seven different ranges of account balances: six ranges of width DKK 250,000 between DKK 250,000 and and DKK 1,499,999 and one range covering all deposits above 1,750,000. The figures shows the point estimates on the interaction terms in different deposit ranges and 95% confidence bounds.

Figure 12: Interest rates on accounts with balances above DKK 1 million



Notes : The figure illustrates the results from an ordinary least squares regression. The dependent variable is the bank-level interest rate on deposit accounts with a balance above DKK 1,000,000 net of the government rate. The explanatory variables are a set of year dummies interacted with indicators that the bank is systemic and non-systemic respectively (no constant term). The figure shows the point estimates on the interaction terms and 95% confidence intervals based on standard errors clustered at the bank-level. The two lines thus indicate the average trend in interest rates for systemic (blue) and non-systemic banks (red). The interest rate differences between systemic and non-systemic banks with standard errors are reported in Figure A9 in the Appendix.

Figure 13: Difference-in-difference estimates by bank size



Notes : The figure illustrates the results from an ordinary least squares regression. The dependent variable is the bank-level value of time deposits (in logs). The explanatory variables are a set of year dummies interacted with indicators that the bank is systemic and non-systemic respectively as well as bank fixed effects. The figure shows the point estimates on the interaction terms and 95% confidence intervals based on standard errors clustered at the bank-level. The two lines thus indicate the average trend in time deposits for systemic (blue) and non-systemic banks (red). The resulting difference-in-difference estimators are reported in Figure A14 in the Appendix.

Table 1: Summary statistics

	(1)	(2)	(3)	(4)
	Systemic banks		Non-systemic banks	
	Mean	SD	Mean	SD
Accounting information:				
Total assets (in DKK billion)	592	906	4	6
Equity-assets ratio	0.05	0.01	0.16	0.06
Loans-assets ratio	0.51	0.11	0.64	0.15
Return on assets	0.008	0.003	0.011	0.008
Exposure to deposit insurance limit:				
Share of deposits > DKK 750,000	0.23	0.06	0.14	0.10
Share of deposits on accounts > DKK 750,000	0.37	0.05	0.28	0.14
	Total		Total	
Number of accounts > DKK 750,000	5,946		2,103	
Number of accounts	470,444		185,494	
Number of banks	6		86	

Notes: *Systemic banks* are the six largest banks by total assets in 2007. *Non-systemic banks* are all other banks. *Total assets* is total bank-level assets. *Equity-asset ratio* is the ratio of total equity to total assets. *Loans-assets ratio* is the ratio of total lending to total assets. *Return on assets* is the ratio of accounting profits to total assets. *Share of deposits > DKK 750,000* is account balances above DKK 750,000 divided by total deposits. *Share of deposits on accounts > DKK 750,000* is depsits on accounts above DKK 750,000 divided by total deposits. *Number of accounts > DKK 750,000* is the number of accounts with a balance exceeding DKK 750,000. *Number of accounts* is the number of accounts with any balance. All variables are recorded in 2007.

Table 2: Baseline results

	(1)	(2)	(3)	(4)
	Deposits (in logs)			
After reform × Above limit	-0.363***	-0.373***	-0.378***	-0.366***
	(0.0462)	(0.0430)	(0.0501)	(0.0500)
After reform	0.292***	0.304***	0.305***	
	(0.0403)	(0.0394)	(0.0456)	
Above limit	-0.578***	-0.593***		
	(0.0214)	(0.0187)		
Equity / debt (in 2007)	1.941			
	(1.452)			
Loans / assets (in 2007)	1.302			
	(0.834)			
Log of assets (in 2007)	0.802***			
	(0.0398)			
Constant	1.154			
	(0.773)			
Observations	3,507	3,507	3,507	3,507
R-squared	0.869	0.951	0.970	0.990
Bank FE	NO	YES	YES	YES
Bank-Range FE	NO	NO	YES	YES
Bank-Time FE	NO	NO	NO	YES

Notes: This table reports the estimated coefficients from ordinary least squares regressions as well as robust standard errors clustered at the bank-level (in parentheses). The dependent variable is the natural logarithm of bank deposits in DKK 50,000 ranges of the interval DKK 500,000 – 1,000,000. *Above limit* is an indicator for deposit ranges above DKK 750,000. *After reform* is an indicator for the years 2010 and 2011. *Equity / debt* measures the ratio of equity to debt. *Loans / assets* meaures the ratio of loans to assets. *Log of assets* is the natural logarithm of total assets. Columns (1)-(4) include all accounts. Column (5) only includes an account in year t if it belongs to individual who owned no accounts with a balance exceeding DKK 750,000 in year t-1. The sample period is 2008-2011. Statistical significance at the 1, 5 and 10 percent levels are indicated by ***, ** and *, respectively.

Table 3: Robustness and mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Baseline	Heterogeneity in bank and customer characteristics			12 largest banks	Definition of systemic banks: top-4	top-5	top-7	top-8	Mechanisms: new accts	existing accts
After reform × Above limit	-0.383***	-0.561***	-0.488***	-0.608***	-0.481***	-0.378***	-0.381***	-0.382***	-0.385***	-0.976***	-0.319***
	(0.0530)	(0.115)	(0.0983)	(0.144)	(0.141)	(0.0519)	(0.0524)	(0.0537)	(0.0543)	(0.123)	(0.0504)
After reform × Above limit × Systemic	0.243***	0.271**	0.231**	0.259**	0.341**	0.269***	0.258***	0.201***	0.208***	0.473**	0.211***
	(0.0599)	(0.107)	(0.109)	(0.121)	(0.144)	(0.0569)	(0.0576)	(0.0751)	(0.0713)	(0.190)	(0.0536)
After reform × Above limit × High capitalization		0.172*		0.117							
		(0.0913)		(0.0806)							
After reform × Above limit × High liquidity		0.141		0.0821							
		(0.0939)		(0.0885)							
After reform × Above limit × High profitability		0.0548		0.0447							
		(0.0935)		(0.0847)							
After reform × Above limit × High average age			0.208**	0.182**							
			(0.0919)	(0.0847)							
After reform × Above limit × High share of female			0.185**	0.169**							
			(0.0879)	(0.0821)							
After reform × Above limit × High average income			-0.177**	-0.132							
			(0.0880)	(0.0869)							
Observations	3,507	3,507	3,507	3,507	480	3,507	3,507	3,507	3,507	2,359	3,490
R-squared	0.990	0.990	0.991	0.991	0.995	0.990	0.990	0.990	0.990	0.955	0.990
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank-Range FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank-Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table reports the estimated coefficients from ordinary least squares regressions as well as robust standard errors clustered at the bank-level (in parentheses). The dependent variable is the natural logarithm of bank deposits in DKK 50,000 ranges of the interval DKK 500,000 – 1,000,000. *Above limit* is an indicator for deposit ranges above DKK 750,000. *After reform* is an indicator for the years 2010 and 2011. *Systemic* is an indicator for being among the largest banks in 2007 in terms of total assets where largest means 4 (Column 6), 5 (Column 7), 6 (Columns 1-5), 7 (Column 8) and 8 (Column 9). *High capitalization* is an indicator for having a ratio of equity to assets above the sample median in 2007. *High liquidity* is an indicator for having a ratio of loans to deposits below the sample median in 2007. *High profitability* is an indicator for having a return to assets above the sample median in 2007. Interest rate is the (bank-range specific) median interest rate on deposits (imputed). *High average age* is an indicator for having customers with average age above the sample median in 2007. *High share of female* is an indicator for having a share of female customers above the sample median in 2007. *High average income* is an indicator for having customers with average income above the sample median in 2007. The sample period is 2008-2011. Statistical significance at the 1, 5 and 10 percent levels are indicated by ***, ** and *, respectively.

Table 4: Exposure to the deposit insurance limit and lending growth

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS reduced form		**Instrumental variable regression**			
	Change in log lending 2007-2011		Change in log deposits 2007-2011		Change in log lending 2007-2011	
			first stage		second stage	
Instrumented change in log deposits (2007-2011)					0.370***	0.345**
					(0.133)	(0.161)
Share of total deposits > DKK 750,000			-1.483***	-1.489***		
			(0.429)	(0.371)		
Share of total deposits > DKK 750,000 × Non-systemic	-0.549**	-0.519*				
	(0.227)	(0.288)				
Share of total deposits > DKK 750,000 × Systemic	-0.153	-0.214				
	(1.328)	(1.279)				
Equity / debt (in 2007)		0.708		-0.217		0.858
		(0.620)		(0.994)		(0.603)
Loans / assets (in 2007)		-0.284		0.393		-0.343
		(0.259)		(0.303)		(0.225)
Systemic (in 2007)	-0.0867	-0.0285				
	(0.305)	(0.296)				
Constant	0.181***	0.246	0.577***	0.362	-0.0326	0.0602
	(0.0381)	(0.222)	(0.0764)	(0.345)	(0.0610)	(0.227)
Observations	92	92	86	86	86	86
R-squared	0.039	0.091	0.098	0.114	0.006	0.114

Notes : This table reports the estimated coefficients from regressions aiming to capture the effect of the deposit insurance reform on bank lending. Columns (1)-(2) present the results from the OLS reduced form for the full sample of 92 banks. The dependent variable is the change in lending (in logs) over the period 2007-2011 and the key dependent varibable is the share of total deposits > DKK 750,000 in 2007 interacted with indicators for systemic and non-systemic banks. Columns (3)-(4) present the results from the first stage of the IV regression for the sample of 86 non-systemic banks. The dependent variable is the change in the log of total deposits over the period 2007-2011 and the key independent variable is the share of total deposits > DKK 750,000 in 2007. Columns (5)-(6) present the results from the second stage of the IV regression. The dependent variable is the change in lending (in logs) over the period 2007-2011 and the key independent variable is the change in total deposits (in logs) over the same period instrumented with the share of total deposits > DKK 750,000 in 2007. Statistical significance at the 1, 5 and 10 percent levels are indicated by ***, ** and *, respectively.

Apppendix

Figure A1: Account-level deposits above and below DKK 750,000

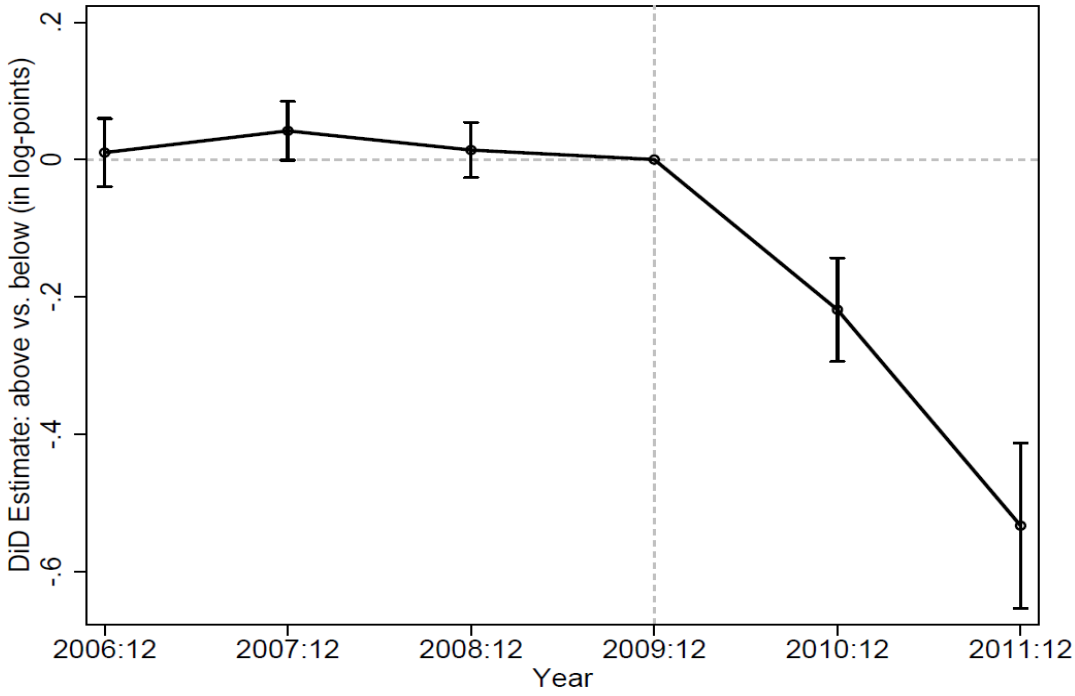
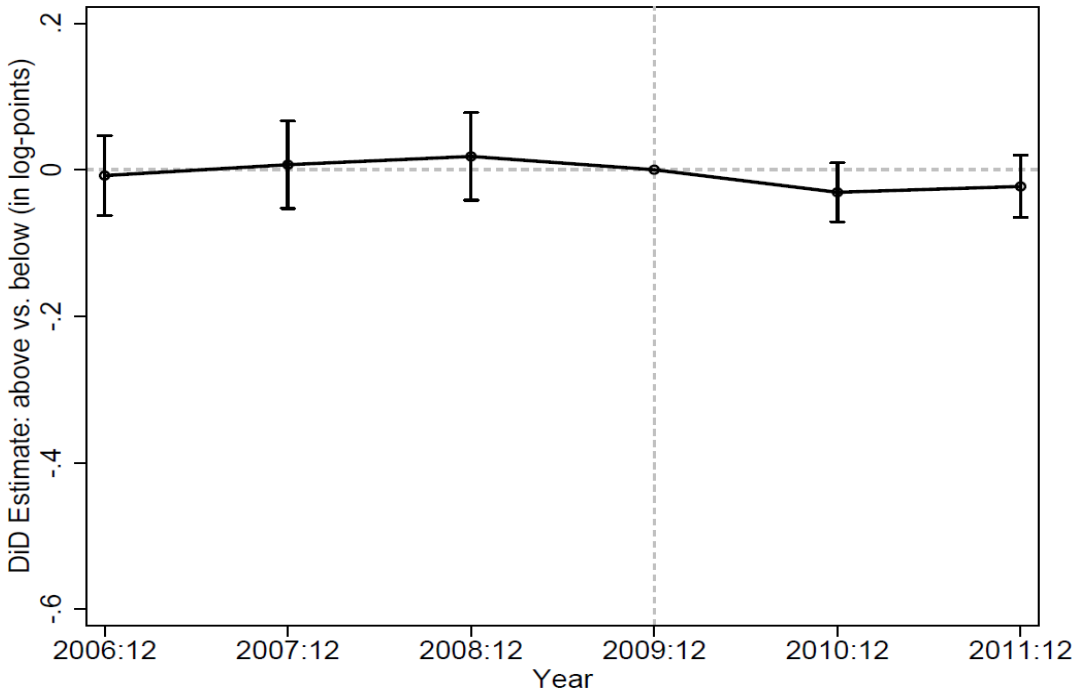


Figure A2: Individual-level deposits above and below DKK 750,000



Notes : Figures A1 and A2 show the difference-in-difference estimates corresponding to Figures 5 and 6: the estimated change in deposits above DKK 750,000 (in log points) relative to the change in deposits below the limit (measured relative to 2009) based on account-level and individual-level deposits respectively.

Figure A3: Deposits in systemic and non-systemic banks

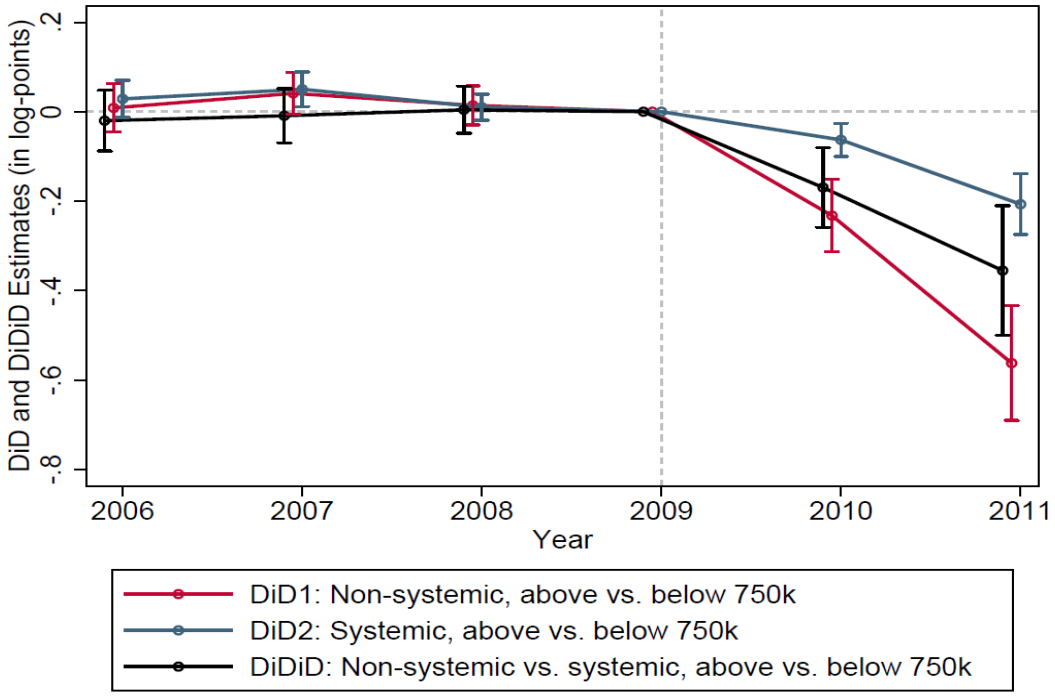
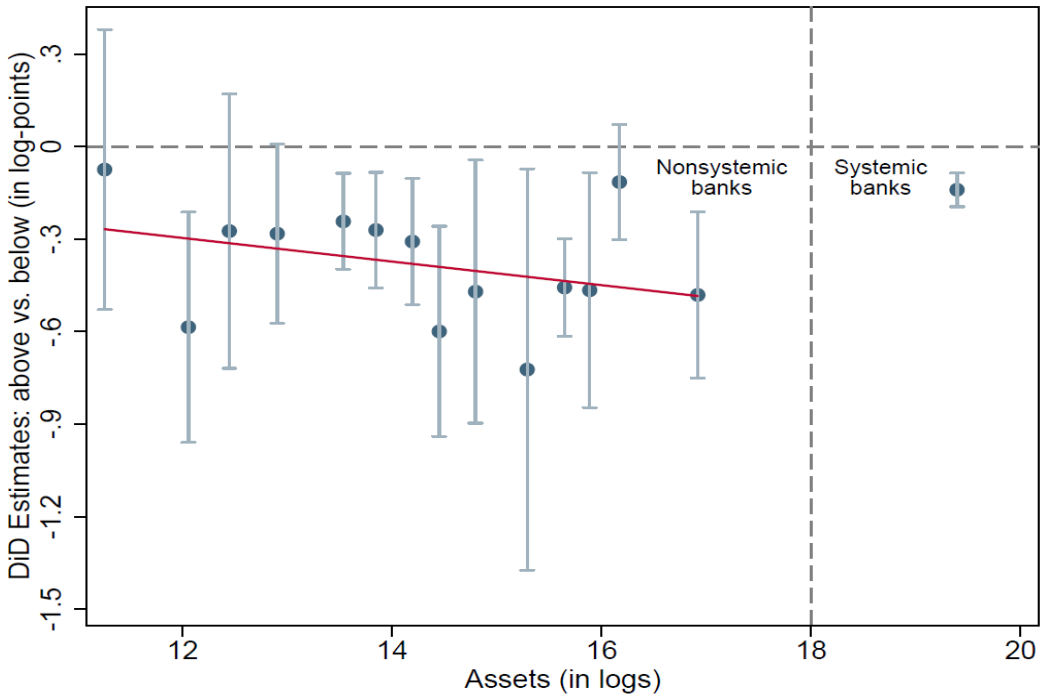


Figure A4: Difference-in-difference estimates by bank size



Notes: Figure A3 shows the difference-in-difference and difference-in-difference-in-difference estimates corresponding to Figure 7: the estimated change in deposits above DKK 750,000 (in log-points) relative to the change in deposits below the limit (measured relative to 2009) in systemic banks (blue line) and non-systemic banks (red line) as well as the difference between these two lines (black line). Figure A4 shows the bank-size specific estimates from Figure 10 with standard errors.

Figure A5: Distribution of accounts 2008-2009, by systemic importance

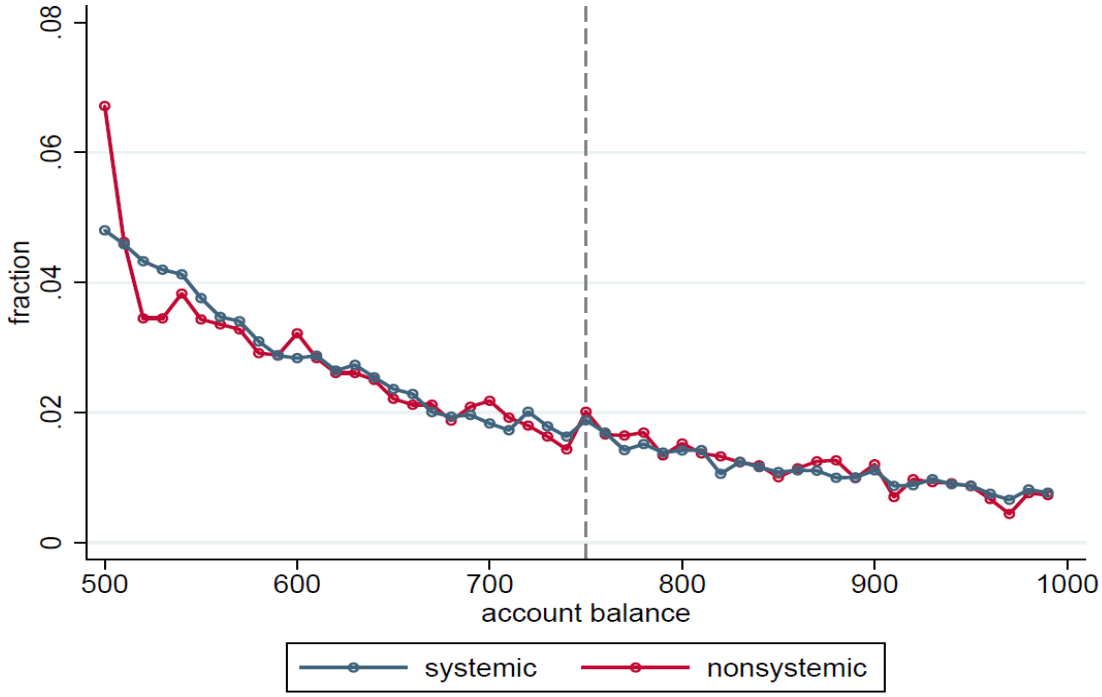
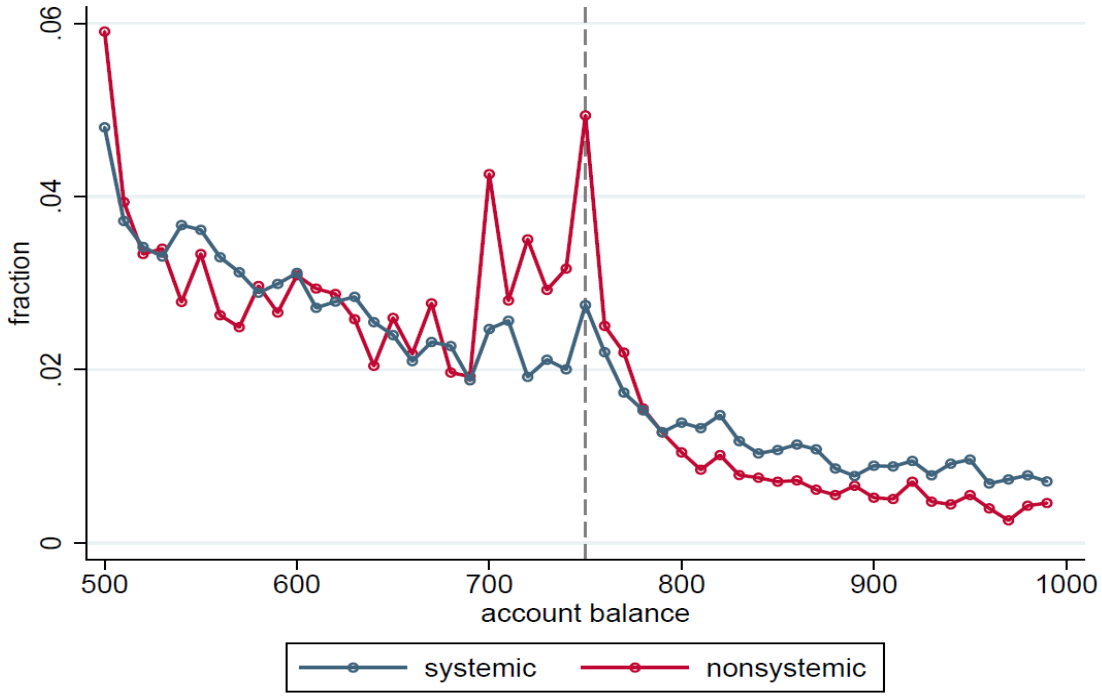


Figure A6: Distribution of accounts 2011, by systemic importance



Notes: Figure A5 and A6 show the distribution of account-level deposit balances (fractions) for systemic and non-systemic banks respectively over the range DKK 500,000 - DKK 999,999 for the years 2008-2009 (Figure A5) and 2011 (Figure A6).

Figure A7: Imputed interest rate (median) and government bond rate

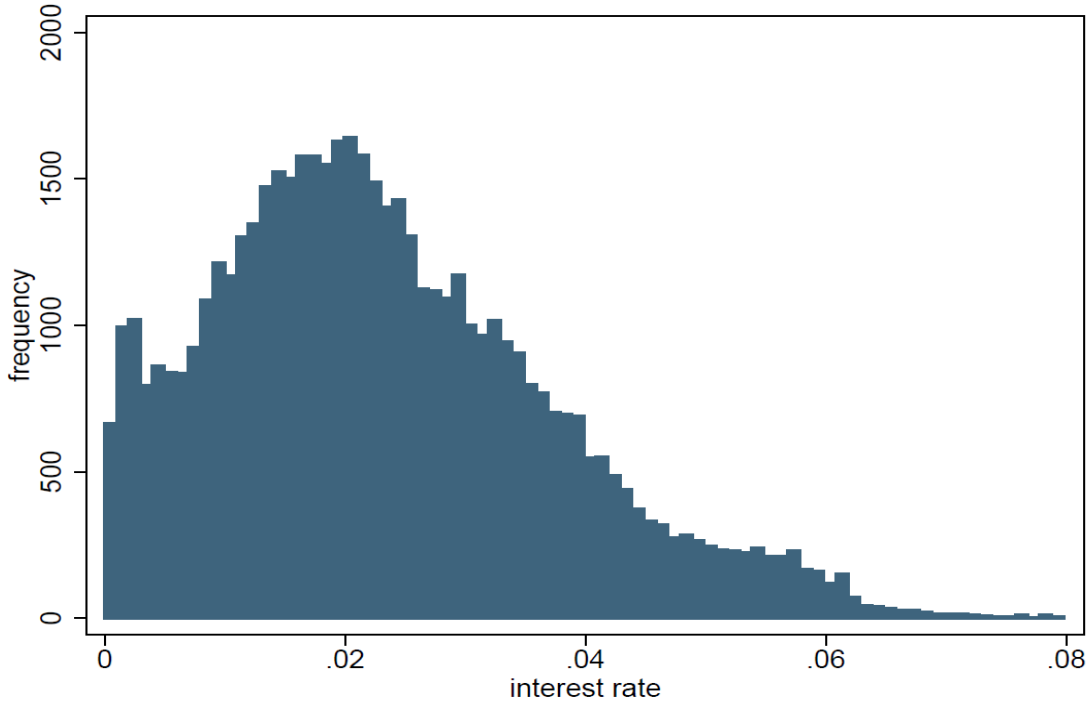
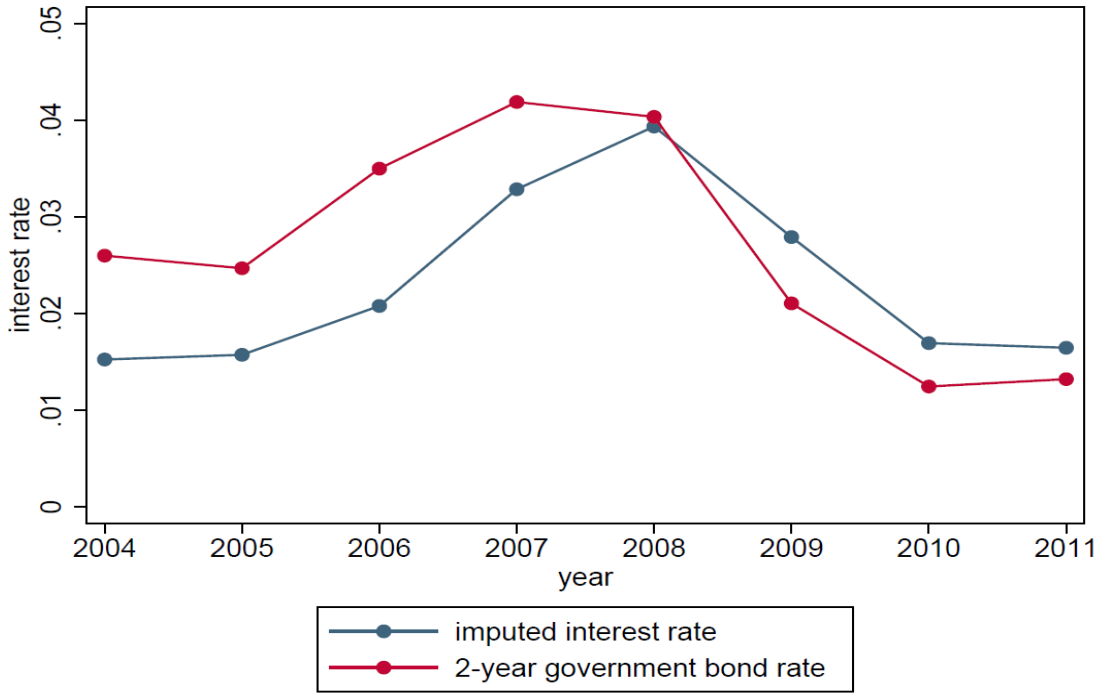
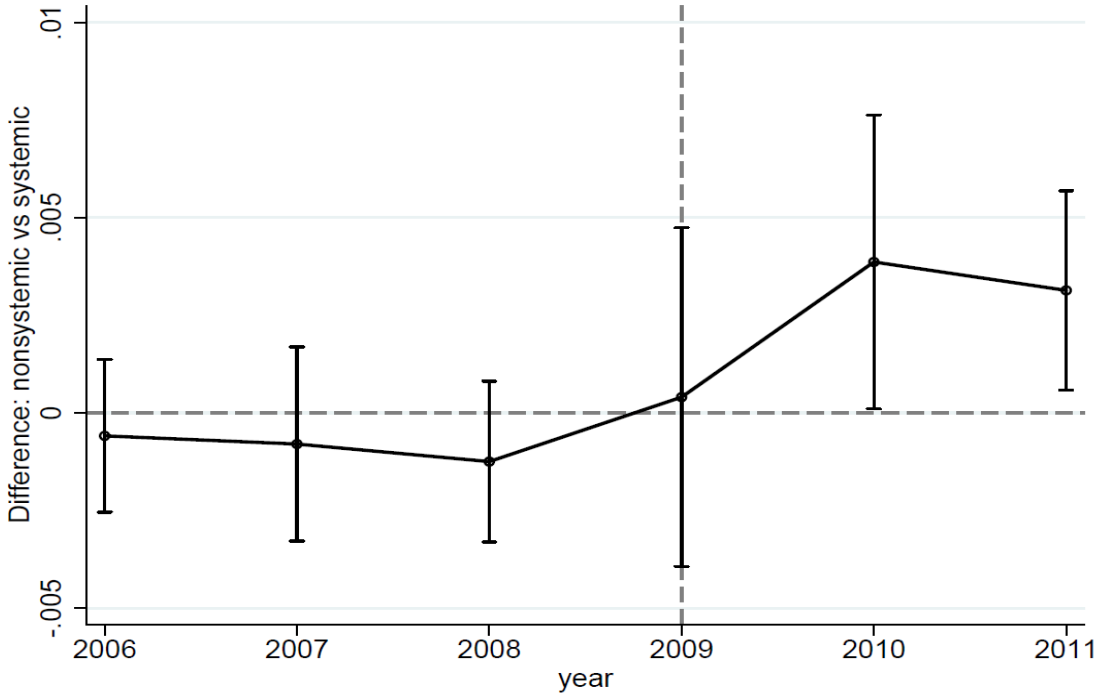


Figure A8: Distribution of imputed interest rates



Notes : Figure A7 shows the distribution of imputed interest rates (censored at the 99th percentile). Figure A8 compares the median imputed interest rate across all deposit acounts to the 2-year government bond rate.

Figure A9: Interest rates on accounts above DKK 1,000,000



Notes : Figure A9 shows the difference between the interest rate on deposit accounts with a balance above DKK 1,000,000 in non-systemic banks and systemic banks respectively.

Figure A10: Difference-in-difference estimates by bank size

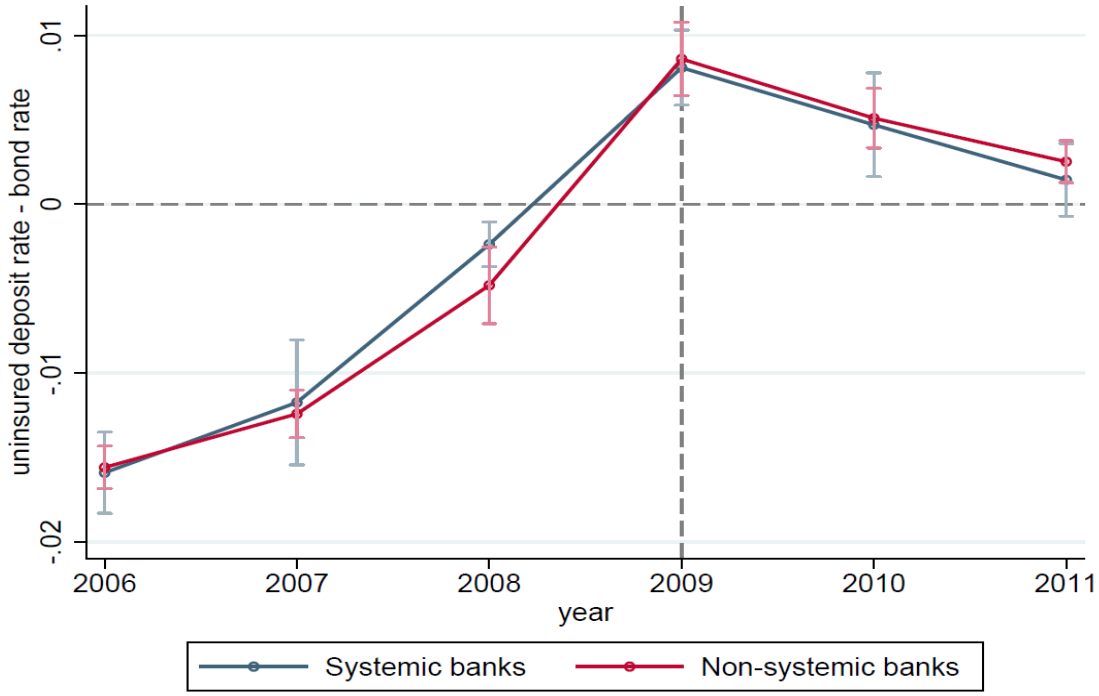
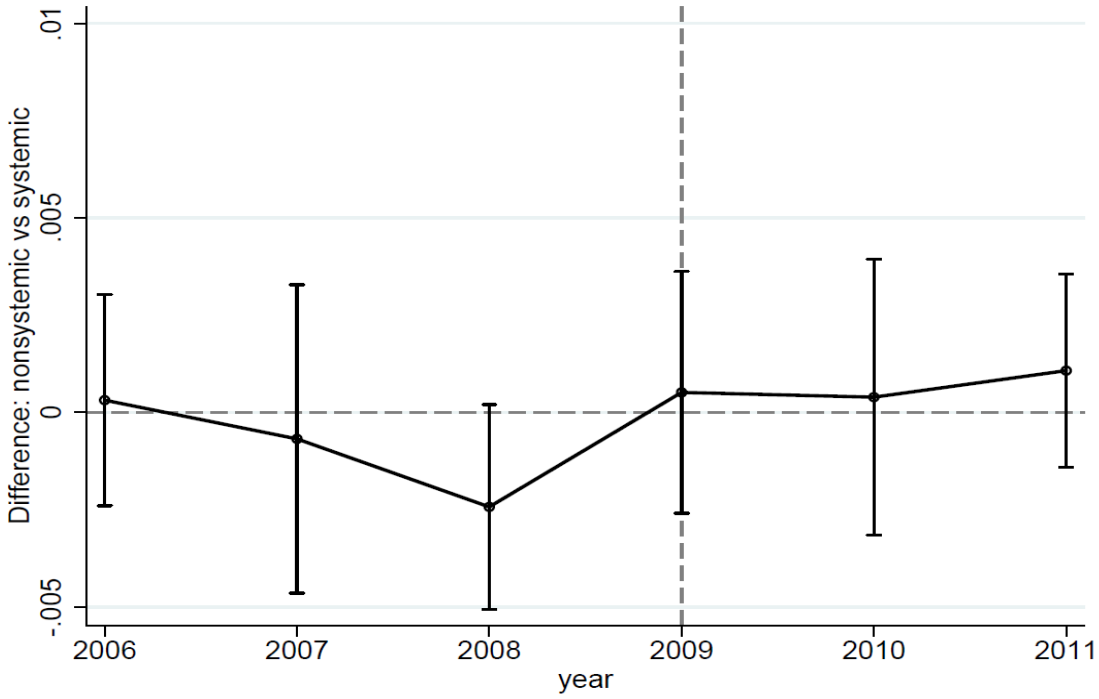


Figure A11: Difference-in-difference estimates by bank size



Notes : Figure A10 shows the analogue of Figure 12, but for deposit balances between DKK 500,000 and 750,000. Figure A11 shows the analogue of Figure A9 but for deposit balances between DKK 500,000 and 750,000.

Figure A12: Difference-in-difference estimates by bank size

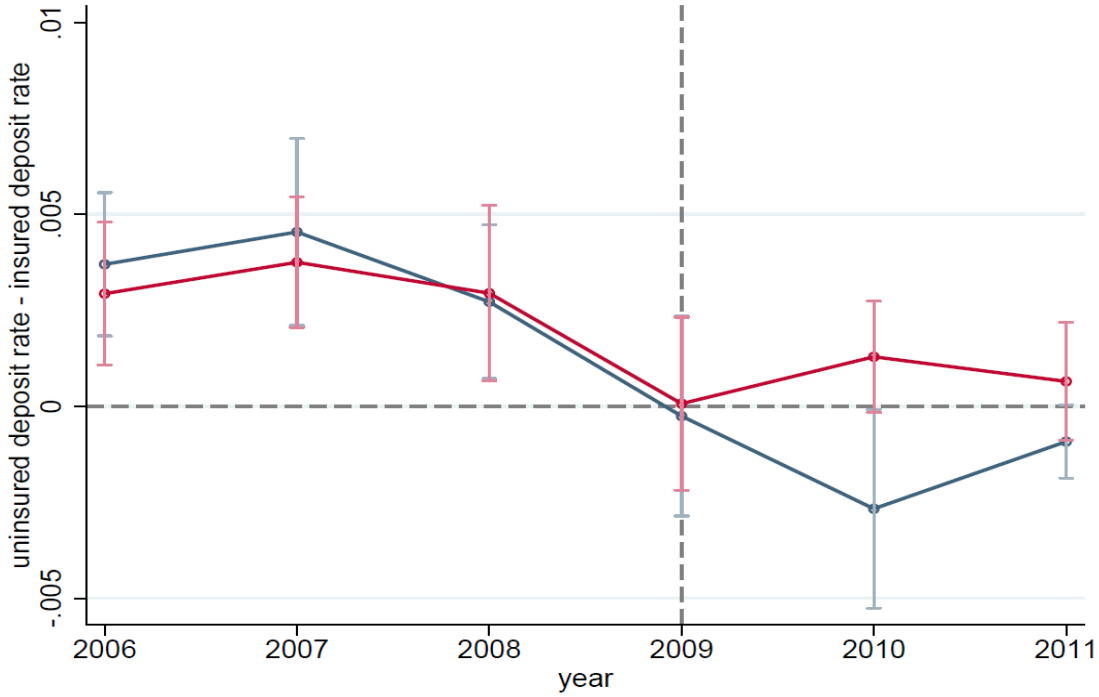
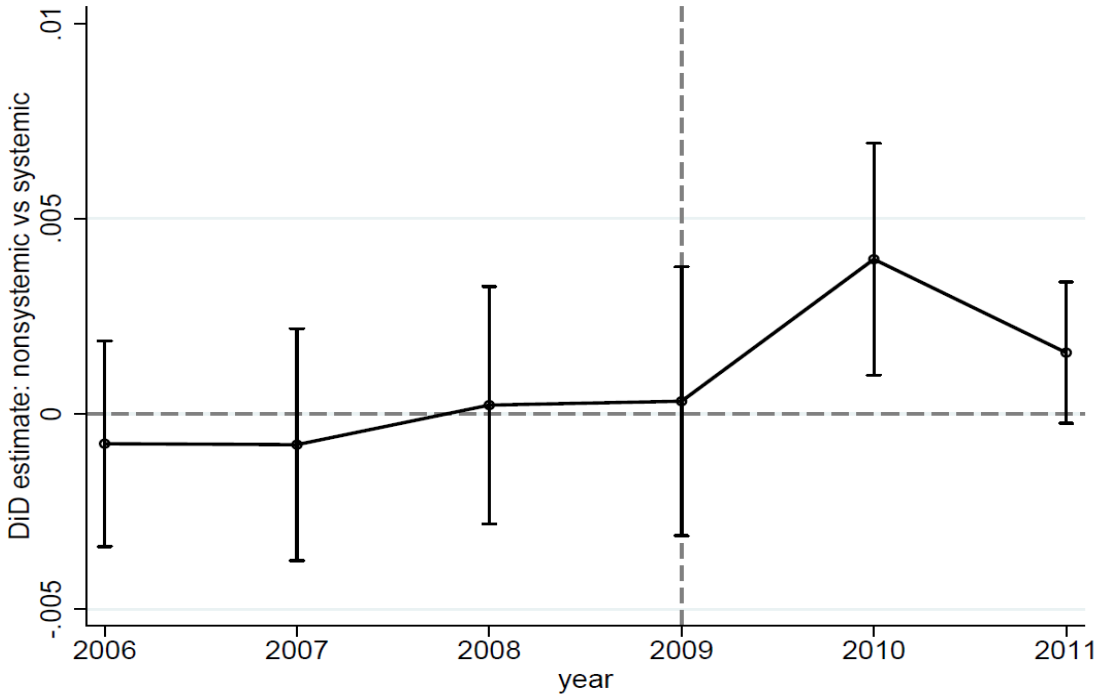
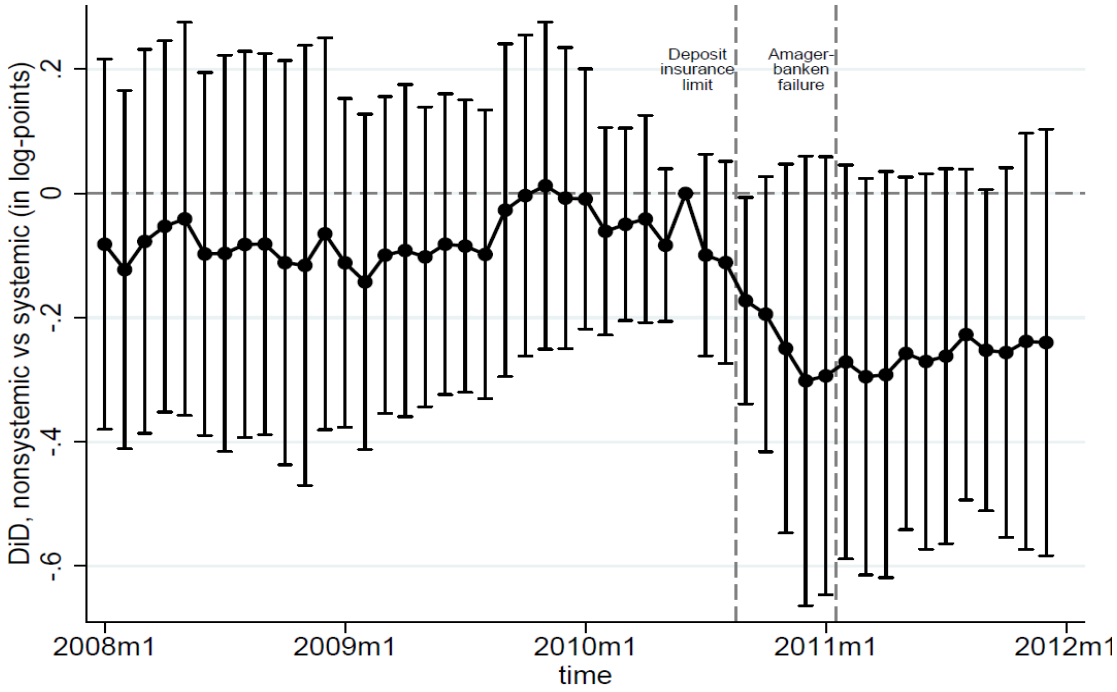


Figure A13: Interest rates on accounts above DKK 1,000,000 vs below DKK 750,000



Notes : Figure A12 shows the analogue of Figure 12, but for the difference between the interest rate above DKK 1,000,000 and the interest rate between DKK 500,000 and 750,000. Figure A13 shows the analogue of Figure A9 but for the difference between the interest rate above DKK 1,000,000 and the interest rate between DKK 500,000 and 750,000.

Figure A14: Term deposits



Notes : Figure A14 shows the difference-in-difference estimates corresponding to Figure 13: the estimated change in time deposits (in log-points) in non-systemic banks relative to systemic banks.

Table A1: Comparison of 10% estimation sample and the remianing 90%

	10% in estimation sample	90% outside estimation sample	Difference in means	P-value that Difference=0
Age	43.94	44.05	-0.11	0.02
	(24.97)	(25.04)		
Female	0.56	0.56	0.00	0.04
	(0.5)	(0.5)		
Partner	0.48	0.48	0.00	0.39
	(0.5)	(0.5)		
Education, short	0.20	0.20	0.00	0.05
	(0.4)	(0.4)		
Education, medium	0.22	0.22	0.00	0.16
	(0.41)	(0.41)		
Education, long	0.09	0.09	0.00	0.08
	(0.29)	(0.29)		
Retired	0.30	0.30	0.00	0.00
	(0.46)	(0.46)		
Self-employed	0.02	0.02	0.00	0.25
	(0.13)	(0.13)		
Unemployed, 24m	32.78	32.70	0.08	0.85
	(146.53)	(146.44)		
# Deposit accounts at systemic banks	0.86	0.86	0.00	0.27
	(0.57)	(0.57)		
# Deposit accounts	1.21	1.21	0.00	0.75
	(0.59)	(0.58)		
Total deposits (DKK)	139,561	139,970	-408.62	0.48
	(296592.4)	(296231.46)		
Total bank debt (DKK)	49,409	49,389	20.02	0.92
	(165894.21)	(167029.36)		
Total debt (DKK)	52,176	52,710	-534.65	0.17
	(201432.21)	(209990.57)		
Total assets (DKK)	427,943	429,236	-1292.59	0.57
	(1061014.96)	(1060683.17)		
After-tax income (DKK)	117,456	117,800	-344.08	0.06
	(87940.62)	(88825.19)		
Stock market participation	0.26	0.26	0.00	0.17
	(0.44)	(0.44)		
Total stock holdings (DKK)	30,443	30,895	-451.75	0.08
	(111849.1)	(112755.04)		

Table A2: Deposit growth above vs below insurance limit

	(1)	(2)	(3)	(4)
VARIABLES	ln_deposits	ln_deposits	ln_deposits	ln_deposits
After reform × Above limit	-0.372***	-0.369***	-0.379***	-0.355***
	(0.0609)	(0.0327)	(0.0308)	(0.0191)
After reform	0.321***	0.322***	0.321***	
	(0.0421)	(0.0242)	(0.0215)	
Above limit	-0.602***	-0.615***		
	(0.0423)	(0.0217)		
Equity / debt (in 2007)	2.452***			
	(0.466)			
Loans / assets (in 2007)	1.514***			
	(0.188)			
Log of assets (in 2007)	0.828***			
	(0.0113)			
Constant	0.540**	13.96***	13.66***	13.96***
	(0.237)	(0.0158)	(0.0108)	(0.0103)
Observations	1,794	1,794	1,794	1,794
R-squared	0.871	0.964	0.984	0.995
Bank FE	NO	YES	YES	YES
Bank-Range FE	NO	NO	YES	YES
Bank-Time FE	NO	NO	NO	YES

Statistical significance at the 1, 5 and 10 percent levels are indicated by ***, ** and *, respectively.