Introduction of deposit Insurance and risk shifting under high capital requirements and firm closure policy

Jan Bartholdy and Lene Gilje Justesen*

Department of Economics and Business Economics,
Aarhus University, Denmark

Corresponding author: Jan Bartholdy, jby@econ.au.dk

Abstract

Can strong prudential regulation curtail risk shifting from deposit insurance? We analyze risk shifting in a universal and transparent banking system with few exposure restrictions on risk-taking but with high capital requirements, a firm closure policy and liquidity requirements. Denmark offers a unique setting because commercial banks and savings banks have different ownership structures but are subject to the same set of regulations. The ownership structure in savings banks implies that they have no incentive to increase risk after the implementation of a deposit insurance scheme whereas commercial banks have. Using a difference-in-difference framework, we show that commercial banks did not increase their risk at the introduction of deposit insurance compared to savings banks. The results also hold for large commercial banks, indicating that the systemic risk did not increase either. Finally, there is no evidence that commercial banks' customers increased their leverage (risk) compared with commercial customers in savings banks. Thus, it appears that prudential regulation can curtail risk shifting from deposit insurance.

Keywords: Deposit insurance, moral hazard, difference-in-difference.

JEL Classification: G21.

This paper is based on the first paper in Lene Gilje Justesen's PhD thesis ((Justesen 2015)) supervised by Jan Bartholdy and Frank Thinggaard. We would like to thank Ken L. Bechmann, Anders Grosen, Marie Herly, Karolin Kirschenmann, Frank Thinggaard, Charlotte Østergaard, participants at DGPE Workshop 2011, participants at D-CAF Workshop in Accounting 2012, participants at the Nordic Finance Research Workshop 2012 and the Finance Research Group at Aarhus University for helpful comments.

* Finance and Risk Management, Jyske Bank, Denmark

1. Introduction

A main concern during a financial crisis is how to prevent bank runs, which are a serious problem if they spread from one bank to the whole system. As shown in (Diamond & Dybvig 1983), deposit insurance may be a solution to this problem. Deposit insurance has been used extensively: in 1986 the European Commission recommended that countries without a deposit insurance system should establish one, and during the recent financial crisis several European countries increased deposit insurance coverage from around 20-25,000 Euro to nearly 100% of the deposits. Although deposit insurance removes the incentive for depositors to withdraw their funds from the banking system, the insurance scheme may also introduce incentives for banks to become riskier. This increases the risk of the overall banking system, referred to as moral hazard or the risk-shifting hypothesis.[1] In practical terms, the costs to the taxpayers from bailing out failed banks may increase due to the higher insurance coverage, but also from the increased risk and therefore higher probability of failure of banks. However, strong prudential regulation may alleviate some of the moral hazard problems from deposit insurance. High capital and liquidity requirements increase the expected costs to the shareholders of increasing risk from moral hazard and a strict closure policy ensures that shareholders pay for the risk by closing down a distressed bank before the advent of bankruptcy (or the onward sale to another bank). Therefore, prudential regulation reduces the incentive by owners to increase risk. The main question addressed in this paper is therefore whether deposit insurance introduced into a universal and transparent banking system with strong prudential regulation leads to moral hazard; strong prudential regulation is here characterized as high capital requirements, a firm closure policy and liquidity requirements, but with few exposure restrictions.

In 1988, Denmark introduced deposit insurance into a universal banking system with few exposure restrictions on risk-taking but high capital requirements, a firm closure policy and liquidity requirements. At this time, Denmark required a ratio of capital to debt plus guaranties of 8%. However, only banks with more than 15% of capital to debt plus guaranties could freely dispose of their income. If the ratio fell below 15%, then 10% of the profit had to be diverted to statutory

[1] This risk shifting has a long history, see e.g. (Merton 1977), (Santomero 1984) and (Goodman & Santomero 1986).

reserves included in the capital. Compared to e.g. the US with a capital to asset ratio of 6%, these requirements were rather strict.[2] During the period 1985 to 1995 a firm closure policy was also enforced: in 1984, there were 225 financial institutions in Denmark ((Tilsynet med banker og sparekasser 1984)), over the following 10 years, 51 institutions entered into financial distress, of which 10 were closed down and the rest were merged with other and stronger institutions ((Mølgaard 2003) p. 67). Finally, financial institutions faced two liquidity requirements: they were required to hold 15% of demand deposit in liquid assets and liquid assets should be at least 10% of loans and guarantees. Denmark operated a universal banking system in which financial institutions were allowed to invest in mortgage and insurance companies, engaging in direct real estate activities as well as holding shares and corporate bonds subject to relatively weak exposure requirements. Thus, as the number of closures indicates, it was possible and indeed the financial institutions did engage in risky activities, but the strong prudential regulation ensured that depositors and taxpayers suffered only negligible losses. Thus, the system introduced in Denmark in 1988 has elements of the system that the EU and Basel IV are now trying to implement. Basel IV attempts to increase capital requirements and the introduction of the Banking Union with a single resolution mechanism attempts to ensure that taxpayers do not suffer losses from the closure of banks. The results presented below are therefore relevant for today's policy environment in terms of showing what happens if deposit insurance coverage increases under Basel IV as well as providing empirical evidence on the risk-shifting hypothesis.

The setting in Denmark is ideal for testing the risk-shifting hypothesis under strong prudential regulation since commercial banks and savings banks are operating under the same regulation, but with different ownership structures. Commercial banks have equity holders with residual rights who will gain from risk shifting, whereas savings banks are self-governed with a non-for-profit motive and, therefore, have no explicit owners with residual rights. Savings banks are controlled by the general assembly where guarantors and depositors have voting rights. Guarantors hold a claim with fixed interest resembling a bond. Thus, savings banks have no incentive to shift risk since guarantors and depositors

[2] Banking regulations, primarily in Danish, can be found at: https://www.retsinformation.dk/forms/R0710.aspx?id=66156. (Pozdena 1992), (Bernard *et al.* 1995), (Bartholdy *et al.* 2003, 2004) provide an overview of the regulatory system in Denmark.

will be hurt from this, and there are no residual owners who will benefit from it. Hence, we have two sets of institutions under the same regulation with different incentives to shift risk in response to the introduction of deposit insurance. This allows us to utilize the difference-in-difference methodology to test if commercial banks increased their risk compared to savings banks after the introduction of deposit insurance. As savings banks are unlisted, we use a battery of risk measures derived from accounting data for the individual institutions to test the risk-shifting hypothesis. As a robustness check, we also perform an analysis on debt to equity ratios of individual industrial firms, exploiting the fact that we can match industrial firms with their financial institution. If commercial banks, after the introduction of deposit insurance, take on more risk than savings banks, they will invest more in risky projects and this will translate into higher debt ratios for corporate customers compared to firms financed by savings banks. Again, we use the difference-in-difference method to test for changes in debt ratios around the introduction of deposit insurance.

Our main contribution to the literature is testing if banks in a universal banking system with few regulatory restrictions on risk-taking but strong capital requirements, a firm closure policy and liquidity requirements increase their risk after the introduction of deposit insurance. The existing literature is divided into at least three strands. In the first strand, a cross-country set-up containing banks in countries with and without deposit insurance is used to test for the relationship between risk and the existence of deposit insurance (e.g. (Bartholdy *et al.* 2003); (Gropp & Vesala 2004)). However, the sample of countries is rather heterogeneous and only a few countries do not have insurance. The existence and the implementation of deposit insurance are also likely to be correlated with other types of regulation, making it difficult to estimate the effect of deposit insurance ((Hovakimian *et al.* 2003)). These problems are overcome in the second strand of the literature by looking at the introduction of deposit insurance in an individual country and comparing the risk-taking behavior before and after the introduction of deposit insurance. (Ioannidou & Penas 2010) analyze the introduction of deposit insurance in Bolivia and (Chernykh & Cole 2011) focus on Russia.

In contrast to Bolivia and Russia, Denmark had a transparent system with a high quality of administration and a low level of corruption and the primary incentive behind the introduction of

deposit insurance was the protection of the banking system.[3] Before the creation of FDIC in the US 1933, eight states in the US introduced deposit insurance, all of which subsequently defaulted. However, the insurance only applied to state chartered banks whereas the Comptroller of the Currency prevented national chartered banks from joining the schemes. This allow for a difference-in-difference analysis of changes in risk and amounts of deposits around the time of the introduction of deposit insurance. The insured state chartered banks (treatment banks) are compared with the uninsured national chartered banks (control banks) at the state level. It is shown in (Calomiris & Jaremski 2016b) that deposit insurance increased risk by removing market discipline and insured banks increased their solvency risk. However, the state chartered banks faced lighter regulation than the national chartered banks and therefore national chartered banks may not be able to replicate the strategy of the state chartered banks.

Our paper uses the same methodology but compares banks and savings banks under the same legislation but with different incentives to exploit moral hazard. Also, our sample includes generally diversified banks and savings banks, ranging from local banks to country-wide banks whereas the sample of insured banks in (Calomiris & Jaremski 2016b) primarily includes unit banks in rural areas.

A third strand of literature analyzes the relationship between risk and deposit insurance before and during the financial crisis. Using a cross-country sample, with the same problems as discussed above, (Anginer *et al.* 2014) show that before the crisis deposit insurance increases risk-taking, but during the crisis deposit insurance decreases systemic risk. (Lambert *et al.* 2015) analyze risk-taking around the time of the implementation of the 2008 Emergency Economic Stabilization Act when the level of insurance coverage for US banks increased from $100,000 to $250,000. (Lambert *et al.* 2015) compare risk-taking by banks facing a significant increase in insured deposits with banks that do not, i.e. they exploit the difference in insurance coverage between the groups. (Lambert *et al.* 2015) show that banks with an increase in insurance and insured deposits raise risk-taking compared with banks that do not face an increase in insured deposits. The effect is strongest for low capitalized banks, suggesting that capital regulation curtails risk-taking from deposit insurance.

[3] For a general discussion of the political motives behind the introduction of deposit insurance, see e.g. (Calomiris & Jaremski 2016a).

In contrast to among others (Lambert *et al.* 2015) and (Calomiris & Jaremski 2016b), we find that on average commercial banks did not increase their risk at the time of the introduction of deposit insurance. Since large institutions may have been protected by the Too-Large-to-Fail doctrine and therefore have always been "insured", we perform the analysis separately for both large and small institutions. The results hold for both large and small institutions; thus, there is no evidence that banks increase their risk when deposit insurance is introduced into a universal banking system with few restrictions on risk-taking but with high capital requirements and a firm closure policy. Nor is there any evidence that the system as a whole increases risk. Finally, our results are confirmed by the robustness check, using debt equity ratios of the customers of the financial institutions. This test confirms our main result that introducing deposit insurance into a strong regulatory environment does not lead to moral hazard.

The paper is organized as follows. Section 2 first presents a literature review and the institutional setting in Denmark. Section 3 describes the data and the measures of bank risk. In Section 4, we present the empirical model and the results of introducing deposit insurance into a strong regulatory environment. Section 5 contains the results from the analysis, followed by the test of robustness in Section 6. Finally, Section 7 concludes.

2.0. Literature Review and Hypothesis

The main motivation for introducing deposit insurance is to increase financial stability, hence to prevent sudden financial panics and bank runs. However, research shows that the success of deposit insurance is highly dependent on the implementation and the institutional environment in which the scheme is introduced (see, for example, (Cull *et al.* 2005); (Demirgüç-Kunt & Kane 2002) and (Laeven 2002)).

When deposit insurance is introduced, several factors may be responsible for moral hazard. First, the insurance premium does not fully reflect the risk of the banks' assets. In some countries, the premium is flat-rate and therefore proportionate with the volume of deposits and completely

independent of the riskiness of the assets.[4] Thus, risky banks pay the same premium as safe banks, which gives an incentive to increase risk and hence the expected return. The Danish system has a flat rate, creating an incentive for moral hazard. However, only deposits up to approximately $ 36,000 were insured, reducing the moral hazard incentive.

Second, under deposit insurance the equity holders have a put option written by the deposit insurance fund. If a bank fails and the funds are insufficient to pay the depositors, they will be paid by the insurance fund. Since the value of an option increases with the volatility of the underlying asset, management has an incentive to increase the risk of the bank to maximize the value of the put option to the shareholders ((Merton 1977)).

Third, once depositors are guaranteed their savings, they have no incentive to monitor the risk-taking of the bank. Without insurance, the depositors will monitor and assess the riskiness of the bank and demand an interest rate that compensates them for the risk. This contrasts the situation with deposit insurance, where the depositors view deposits as risk free and only demand the risk free rate of interest regardless of the risk of the bank. The bank can therefore fund itself at the risk free rate and invest in risky assets.

There are several ways to mitigate the problem of moral hazard. In theory, moral hazard is reduced or eliminated by a risk adjusted premium on the insurance, but in practice it is neither possible nor desirable to price deposit insurance fairly because of private information ((Chan *et al.* 1992); (Freixas & Rochet 1998)). Putting a cap on the insurance means that uninsured depositors will monitor and demand a risk premium on large deposits, curtailing the gains from and the incentive to increase risk. The potential loss of the charter value may also curtail the risk incentives ((Acharya 1996); (Schenck & Thornton 2016)). Finally, the combination of high capital requirements and a firm closure policy can reduce moral hazard as well.

[4] For a discussion of the various deposit insurance systems in different countries, see (Demirgüç-Kunt *et al.* 2008).

A relatively large body of literature has tested the moral hazard hypothesis, i.e. the risk shifting by banks to deposit insurance funds. US based research finds a positive relation between bank failure rates and the introduction of deposit insurance in the 1920s ((Wheelock 1992; Wheelock & Wilson 1995); (Alston *et al.* 1994)), as well as higher risk-taking ((DeLong & Saunders 2011); (Calomiris & Jaremski 2016b)). With focus on the savings and loans crisis in the US during the 1980s, research yields similar results with respect to moral hazard ((Kane 1989); (McKenzie *et al.* 1992); (Cole 1993)). Additionally, (Grossman 1992) finds an increase in risk over time for newly insured thrift institutions. (Carr *et al.* 1994) and (Carr *et al.* 1995) find a significant increase in bank failures after the introduction of deposit insurance in Canada. They argue that this increase is not due to macroeconomic shocks. Contrary to the results in Canada, the failure rate in Denmark does not increase after the introduction of deposit insurance. (Gropp *et al.* 2014) show that due to a law suit in 2001, deposit insurance, in the form of government guarantees, is removed from German savings banks and these banks decrease their risk by dropping risky customers. They use the same methodology as the present paper by comparing savings banks where deposit insurance is dropped to banks not affected by the lawsuit and therefore still covered by deposit insurance. These results are also confirmed by countries with high deposit insurance coverage experiencing more banking crises ((Demirgüç-Kunt & Detragiache 2002); (Kam Hon 2011)). Based on cross-country data, (Hovakimian *et al.* 2003) find that deposit insurance has adverse effects in countries with low political empowerment and high corruption. Additionally, studies using option pricing theory link moral hazard to the mispricing of deposit insurance and here (Marcus & Shaked 1984) show that insurance is overpriced, and (Duan *et al.* 1992) find evidence that some banks indeed do shift their risk to the insurance fund. Additionally, (Bartholdy *et al.* 2003) find that the risk premiums on large uninsured deposits are higher in uninsured countries compared to insured countries, indicating that financial markets are aware of the moral hazard problems. Similarly, when announcing the introduction of deposit insurance, the stock market reaction to large listed banks is positive ((Bartholdy *et al.* 2004)). Thus there seems to be strong evidence for the moral hazard hypothesis; however, this study differs from the existing literature by analyzing the introduction of deposit insurance into a universal banking system with high capital requirements and a firm closure policy.

In a perfect regulatory system with no asymmetric information, with continuous monitoring and where assets and liabilities are reported at market values, there will be no losses to depositors. If the value of

equity in a bank falls below the regulatory level, then the bank is closed with no losses to creditors and depositors. In such a system there is no need for deposit insurance. However, the existence of asymmetric information is a reality and financial institutions are not continuously monitored.

Capital requirements are stated in terms of accounting values, but funds to depositors and creditors are paid from market values and due to asymmetric information the market values are not known at the time of closure. Based on accounting values, the real values could be significantly different at the time of closure. Therefore, capital requirements provide a buffer for the depositors and bondholders. High capital requirements and a firm closure policy reduce the potential losses to depositors and also curtail the incentive for shareholders to pursue high risk since they bear the losses. If the accounting value of capital falls below capital requirements, then the financial institution is either closed or acquired by another institution. If the institution is closed, then the charter value of the institution is lost. On the other hand, if it is acquired, then the shareholders can recover parts of the charter value in the negotiation of the sales price. Liquidity requirements restrict the growth level and therefore the risk of the institution as well as the pay-off from pursuing higher risk from growth. Finally, explicit exposure requirements can limit the risk in the loan portfolio, and prohibiting the banks from engaging in investment banking etc. also reduces the possible risk-taking.

(Grossman 1992) exploits differences in regulatory regimes across US states in the 1930s and finds that thrifts operating under more permissive regimes are riskier than those operating under more restrictive regimes. (Demirgüç-Kunt & Detragiache 2002) show that countries with weak institutional environments are more exposed towards the adverse effects of introducing deposit insurance. Hence, they suggest that the moral hazard implication inherent in explicit deposit insurance may be less of a problem when introduced into a strong regulatory environment such as the Danish environment. (Hovakimian & Kane 2000) analyze the period 1985-1994 in the USA and conclude that capital requirements cannot prevent risk shifting by banks. Finally, (Nier & Baumann 2006) find that deposit insurance decreases capital buffers in individual banks across countries.

Another strand of research analyzes the link between risk-taking behavior and the ownership in commercial banks and savings banks. The literature makes use of the same assumption as in the

present paper, i.e. that savings banks have no incentive to exploit risk shifting whereas shareholders in commercial banks gain from risk shifting. Thus, deposit insurance increases risk in commercial banks compared with savings banks. Consistent with this, (Karels & McClatchey 1999) find that deposit insurance does not lead to increased risk-taking in the credit union industry in the US during the 1970s. Stock owned mutual savings and loans institutions are found to be more risky than institutions under mutual ownership; however, both types of institutions increase their risk following deregulation ((Esty 1997); (Fraser & Zardkoohi 1996)). Also, mutual savings and loans institutions shifting from mutual ownership to stock ownership increase their risk ((Cordell *et al.* 1993); (Esty 1997)). (Iannotta *et al.* 2007) find that European mutually owned banks have better loan quality and lower asset risk than privately owned banks. Similar to our study, (García-Marco & Robles-Fernández 2008) analyze whether Spanish commercial banks and savings banks have different risk-taking behavior. Their analyses show that commercial banks are willing to take higher risk compared to savings banks, which they attribute to the moral hazard from deposit insurance. In this literature, the main problem is the identification of higher risk with deposit insurance. The difference in risk between commercial and savings banks may, in principle, be due to different strategies etc. requiring a careful specification of the models controlling for these effects. In this paper, we also make use of the different incentives for risk shifting between commercial banks and savings banks, but we solve the identification problem by looking at the introduction of deposit insurance and the change in risk around the time of the introduction. Thus, this paper presents a somewhat cleaner test of the link between the existence of deposit insurance and risk-taking in financial institutions than the existing literature.

Prior literature shows that moral hazard is a problem when deposit insurance is introduced, that regulation may reduce this risk-shifting behavior of banks and that mutually owned institutions take less risk than institutions owned by stockholders. This study contributes to this existing literature by providing empirical evidence that the moral hazard implications inherent in a deposit insurance scheme are reduced when introduced into a regulatory environment with high capital requirements and a firm closure policy.

2.1. The Institutional Setting in Denmark

Until 1975, the regulation for the commercial banks and the savings banks differed in that savings banks were restricted in the type of business they were allowed to undertake.[5] In principle, savings banks were not allowed to issue loans unless they were completely safe and loan losses were therefore rare in savings banks.[6] Due to this restriction, savings banks provided loans at low interest rates and long maturities to e.g. local authorities. With increasing interest rates, the funding costs increased and because of these fixed low loan rates, the earnings problems in savings banks started. Although savings banks also had some advantages over commercial banks, for example they were exempt from paying taxes and had lower capital requirements, they had significantly lower growth rates. Right after the Second World War, the total assets of all savings banks and commercial banks were about equal but by 1975, the total assets of commercial banks were 2.3 times as large ((Baldwinsson *et al.* 2000)).

In the Act of 1974 (which came into effect in 1975), Danish savings banks were subject to the same set of regulations as the commercial banks.[7] Savings banks could now offer the same services as commercial banks and the only remaining regulatory difference was a restriction in term of ownership structure. This prevented savings banks from raising capital on financial markets, limiting their growth opportunities. The ownership restriction was removed in 1988, making it possible for savings banks to convert to joint-stock ownership. In 1988, there were 76 independent banks and 138 savings banks.[8] During the 1990s, ten savings banks converted to joint-stock companies including the five largest that represented about 85% of the total assets of all savings banks ((Baldwinsson *et al.* 2000)).

Overall, the Danish banking system was highly regulated up to about 1980. In particular, there were restrictions on the amount of corporate and private lending, referred to as a "lending ceiling". This restricted internal growth, hence the only way of growing was by acquiring other institutions.

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[5] (Pozdena 1992); (Bernard *et al.* 1995) and (Bartholdy *et al.* 2003) provide a description of the Danish regulatory system during the period. Eigil Mølgaard, head of the Supervisory Authority during the period, provides a narrative of the regulatory authority during the period 1987 to 1995 in (Mølgaard 2003). The regulation in force at the time of publication, i.e. on August 15, 1985, can be found on https://www.retsinformation.dk/forms/R0710.aspx?id=66156 (accessed on February 28, 2015).

[6] Other restrictions included prohibitions on securities trading as well as currency and foreign transactions.

[7] Danish financial institutions faced few restrictions. They could provide stock brokerage, investment banking and merchant banking services. Finally, there were no geographical or branching restrictions.

[8] The numbers are from the 1988 annual report of the Danish Financial Supervisory Authority and include commercial banks and savings banks in Greenland and the Faroe Islands.

Institutions in distress were obvious targets. Until 1980, all distressed banks in Denmark were acquired by other institutions without loss to depositors or taxpayers.

After 1980, the financial system was liberalized. In particular, the lending ceiling was gradually reduced and completely removed in 1985. With this deregulation it was possible to open new institutions or simply change the strategy, for example to offer high rates on deposit and to invest in high risk projects. Additionally, foreign funding and deposits increased during the 1980s.[9] Hence, the removal of the lending ceiling, the liberalization of the barriers to entry and the access to foreign funds made it easier to obtain internal growth, which reduced the need for acquisitions as a means to obtain growth. At the same time, the liberalization and competition from abroad required restructuring and consolidation of the industry and as a result, the savings banks were consolidating small local savings banks into regional institutions.

Thus until 1980, institutions in distress were in general closed with positive equity (firm closure policy) and acquired by other banks in search of growth. After deregulation, new high-risk institutions had opened and some of these went into distress. Whereas the existing institutions were willing to acquire banks in distress before the deregulation, this was not the case anymore. Presumably, the reason for this was that equity was negative in the distressed institutions and therefore the acquirer had to compensate both depositors and creditors, and growth could be obtained cheaper elsewhere. Before 1980, financial institutions in financial distress were acquired by other financial institutions in order for them to grow. After 1980, with the advent of high-risk institutions, there was an understanding in the industry that this regime could not continue, i.e. the financial institutions operated under the presumption that there was no informal deposit insurance scheme.[10] There was a general concern in the industry that bankruptcy and subsequent losses to depositors of these new high-risk institutions would damage the reputation of the entire banking system, leading to systemic risk.

[9] For large banks, foreign funding (deposits) increased from 15% of total assets in 1981 to 25% in 1989. For the medium-size banks, it increased from 5% to 15%.

[10] These are the personal views of the authors based on interviews with Lars Eskesen and Eigil Mølgaard. Lars Eskesen was Chairman of the Danish Savings Banks Association from 1985 to 1989 and Eigil Mølgaard was Director of the Danish Financial Supervisory Authority from 1988 to 1996.

In 1986, the European Commission recommended that all countries without a deposit insurance system should establish one, and after the failure of C&G Banken, the Danish deposit insurance scheme went into effect in February 1988. A fund was established, covering deposits in commercial banks, savings banks, branches of foreign banks as well as deposits in other financial institutions. The financing came from a levy on total deposits. The maximum insured limit was DKK 250,000 (approximately $ 36,000). In case of a large default and insufficient funds in the scheme, the insurance fund could borrow with government guarantee.[11] From 1988 until 1995, the insurance fund covered deposits in eight smaller commercial banks and savings banks and contributed to the acquisition of Klejstrup Andelskasse.[12]

The Danish banking structure was dominated by a few large commercial banks and savings banks. Den Danske Bank was the largest bank with a share of the total assets for all commercial banks and savings banks of nearly 17%. The largest savings bank, SDS, had a share of 10%. However, by 1995 the only remaining savings bank in top ten was Sparekassen Kronjylland, as the other savings banks had either merged or converted to joint-stock companies (i.e. become commercial bank). By 1990, the market share of Den Danske Bank had increased to about 35% due to a large merger. Of the commercial banks in top ten, Den Danske Bank, Jyske Bank, Sydbank and Arbejdernes Landsbank still exist in 2017. In 1988, there were about 40 banks per million inhabitants in Denmark, whereas in the US there were 60 banks per million (partly due to branch restrictions) ((Pozdena 1992)). The level of market concentration and branch coverage suggests that no institution had monopoly power. The lack of foreign banks indicates that the Danish banks were also efficient.

2.2. Ownership Structure

Denmark has a two-tier board system with an executive board and a separate supervisory board; this is common for both types of banks. As commercial banks have joint-stock ownership, they are under the Companies Act. The highest authority of a commercial bank is the annual general meeting where the

[11] See (Bartholdy *et al.* 2004) for further details on the insurance scheme and its introduction in Denmark.
[12] C&G Banken, Fossbankin, Lannung Bank, Samson Bankier, Benzon Bankier, Højderyggens Andelskasse, Grølsted Andelskasse and Lindknud-Hovborg Andelskasse. Information is based on the annual report of the Deposit Insurance Foundation (1995).

shareholders have voting rights. It is possible for banks to have voting ceilings for individual shareholders, which increases the dispersion.[13] As in other joint-stock companies, the shareholders have the residual claim to the cash flow from the bank.

Contrary to commercial banks, savings banks have no owners with residual cash flow rights because the institutions are self-governing.[14] Their capital comes from two sources, namely retained earnings and guaranteed capital. Guaranteed capital resembles both bonds and equity. The savings banks pay a fixed interest to the guarantors, and both the interests and incentives of the guarantors are therefore like those of bondholders in a joint stock company. However, they also resemble equity since the guarantors have voting rights. Savings banks are required to have a committee of representatives, which corresponds to the annual general meeting of commercial banks. This committee consists of at least 21 members who are elected either by depositors, depositors together with guarantors or by guarantors alone. One depositor has one vote, whereas a guarantor has one vote for every DKK 1,000 paid as guaranteed capital, however, with a maximum of 20 votes ((Jensen & Noergaard 1976)). Thus, because the "owners" or decision-makers in savings banks have no claim to the yearly profits, their interests and incentives resemble those of the depositors and bondholders in commercial banks.[15] Therefore, savings banks have no incentive to increase risk in response to deposit insurance.

2.3. Prudential Regulation

Danish banks are regulated by the Danish Financial Supervisory Authority (in Danish: Finanstilsynet).[16] In the late 1980s, commercial banks and savings banks were required to maintain a capital to asset ratio of at least 15% to have their profit freely available for dividend payments.[17] The minimum level of capital was 8% and failing this, the Ministry of Economics and Industry could withdraw the license. The

[13] As shown by (Iannotta *et al.* 2007), a higher ownership concentration in banks leads to lower asset and insolvency risk; hence, high dispersion is most likely related to higher risk-taking.
[14] Savings banks tend to use their profits to support activities in the local community.
[15] During the time period in question, the management of commercial banks and savings banks did not have performance dependent pay in the form of option programs etc.
[16] For a discussion of the Danish regulatory system, see (Pozdena 1992); for the use of market value accounting, see (Bernard *et al.* 1995).
[17] Capital is equity plus certain forms of subordinated debt where 40% of the capital could be provided from subordinated debt.

board and the auditor were required to report to the Supervisory Authority if they believed that the capital requirement was not satisfied. Additionally, banks were required to hold 15% of the short deposits in liquid assets, and liquid assets should be at least 10% of the loans. If these requirements were not met, the banks should report to the Financial Supervisory Authority within eight days; otherwise, it could lead to personal fines and imprisonment.

The strong capital requirements were supported by mark-to-market accounting, i.e. the balance sheet must be shown at actual or commercial value. For traded stocks and bonds, the banks were required to use market values from the Copenhagen Stock Exchange. Considering that real estate financing is based on mortgage bonds trading on the stock exchange, and that banks hold a large proportion of these bonds, a large part of a bank's balance sheet constitutes traded assets. For non-traded assets, banks were required to make adjustments in the booked value in case of changes in interest rates, exchange rates or any general changes in values. Individual loans had to be written down if the banks either expected losses or had suffered actual losses (Pozdena 1992).

The closure process in Denmark is initiated by the Danish Financial Supervisory Authority, often on a Friday and often with a potential buyer at hand. During the weekend the institution is then acquired and opened on the following Monday. In such a set-up, the bargaining position of the closed institution is not particularly strong and the existing shareholders stand to lose parts of the charter value. This potential loss in charter value in case of closure or acquisition reduces the incentive for risk-taking.

In 1988, the largest commercial banks and savings banks had a relatively strong capital position and combined with a firm closure policy by the Supervisory Authority this ensured that most banks in financial distress were acquired by other banks during the banking crisis of the 1990s. Denmark entered a turbulent period around 1990 with a banking crisis and opening of markets in the EU. During the period 1985 to 1995, financial distress and strategic restructuring led to the closure of 102 financial institutions; however, most ended up being acquired by another institution. Of these 102 institutions, 51 were in financial distress and the Supervisory Authority was involved in 47 of these cases ((Mølgaard 2003) p. 67). During this period, only ten financial institutions went bankrupt without being acquired by another bank. As they were all small institutions, nine required limited payouts from the insurance

fund.[18] The acquired banks were closed and re-opened "the next day" as part of the acquiring bank with no losses to the depositors.

Finally, a set of liquidity requirements were in place with a liquidity requirement of 15% of demand deposits and a requirement that liquid assets should be at least 10% of loans and guarantees.

From 1991/92 the Danish banking system adopted the risk based Basel I system, which in effect resulted in lower capital requirements for Danish banks.

2.4. Other Regulation

The 1988 Danish banking system was a universal system; thus, financial institutions were allowed to engage in mortgage, investment/merchant banking, brokeage and insurance activities. The general regulatory environment did not overly restrict the engagement in risky activities in terms of loans and investments. Subject to exposure regulation, financial institutions were allowed to invest directly in corporate bonds and stocks, to make direct real estate investments and, through subsidiaries, to invest directly in mortgage companies. These activities were subject to exposure restrictions to a maximum of 35% of equity for each customer and a 15% restriction on share ownership of individual companies.[19] The maximum level of real estate ownership (excluding real estate for the purpose of banking operations) or real estate companies (excluding real estate used for banking operations) was 20% of equity in the financial institution.

None of these regulatory restrictions prevented financial institutions from significantly increasing risk by e.g. increasing the gearing of a customer's portfolio or investing in risky stocks.

Summary

[18] The following institutions went bankrupt: C&G Banken, Fossbankin, Lannung Bank, Samson Bankier, Benzon Bankier, Højderyggens Andelskass, Grølsted Andelskass, Lindknud-Hovborg Andelskass, Bornholmerbanken and Himmerlandsbanken ((Mølgaard 1993) and the annual report of the Deposit Insurance Foundation 1995).
[19] The regulation in force between 1985 and 1989 can be found on https://www.retsinformation.dk/forms/R0710.aspx?id=66156.

The Danish regulatory system in 1988 was a liberal universal system in which the main regulatory tools were high capital requirements, a firm closure policy and liquidity regulation. Thus, from a regulatory point of view, it was possible for the financial institutions to increase risk to exploit the moral hazard benefits of deposit insurance although the high capital requirements and firm closure policy would reduce the expected gains from this strategy.

In this paper, we exploit the fact that Danish commercial banks and savings banks are under the same regulation but have different ownership structures. The difference is that shareholders (decision-makers) in commercial banks have the residual right to the cash flow from the bank whereas the guarantors in savings banks do not. Therefore, the shareholders in a commercial bank have an incentive to increase risk because this increases the expected return, contrary to decision-makers in savings banks who are more interested in a sound financial business plan because they do not gain from increased risk and potential higher returns.

Before the introduction of deposit insurance, the Danish banking industry had only experienced few failures (and even fewer with losses to depositors). However, Denmark did not operate a system with implicit deposit insurance.[20] Thus, from the viewpoint of the financial institutions, deposit insurance was introduced into an uninsured system. Due to their ownership structure, it was optimal for commercial banks to increase risk and thereby increase the risk of the financial system in such an environment. However, in the period around the introduction of deposit insurance Denmark had a strong regulatory system characterized by high capital requirements and a firm closure policy. This is expected to curtail the risk shifting behavior of commercial banks.

3.0. Data

The analyses include Danish commercial banks and savings banks between 1985 and 1990, where the deposit insurance scheme was approved in Parliament in December 1987 and went into effect in

[20] This is confirmed by interviews with Eigil Mølgaard and Lars Eskesen as well as by the bankruptcy of C&G Banken in 1987/88 that resulted in losses to depositors.

February 1988.[21] The data is hand-collected from annual reports from the Supervisory Authority. The data tables in the annual reports include sub-totals, making it possible to test the data. If the tables include mistakes, then the financial institution is dropped from the year in question. Thus, the number of institutions in our sample differs slightly from the number of institutions indicated in the annual reports.

Please insert Table 1 here.

Table 1 shows the total number of commercial banks and savings banks in Denmark, divided into size categories as defined by the Supervisory Authority. The decline during the period is primarily caused by mergers between the two types of banks. From the table, we can see that there are no commercial banks in the "very small" group. Hence, we have excluded the "very small" savings banks from the analysis because no comparable commercial banks exist. After 1988, some of the savings banks converted to commercial banks (i.e. joint-stock ownership), and these are coded as savings banks for the years in which they were savings banks and banks after they changed.

Please insert Table 2.

A summary of the aggregate balance sheet information for Danish banks is provided in Table 2. We see that in general all banks reduced their loan portfolio after the introduction of deposit insurance, increased their deposits with more than one month to maturity and reduced their deposits with less than one month to maturity. This contrasts Carapella and Giorgio (2004) who find that across 55 countries banks increased their lending after the introduction of deposit insurance. Since the increase in loans was not backed up with a similar increase in deposits, (Carapella & Giorgio 2004) confirm the moral hazard hypothesis of an increase in risk-taking after the introduction of deposit insurance. Foreign funding as well as deposits with foreign banks generally decreased. Finally, the amount of equity increased for all institutions. Based on these descriptive statistics, there is no clear picture of increased risk-taking by commercial banks compared to savings banks.

[21] See Bartholdy, et al. (2004) for an overview of the events around the introduction of deposit insurance.

3.1. Measures of Bank Risk

The primary focus of this paper is to see whether commercial banks increased their risk compared to savings banks after the introduction of deposit insurance. In general, there are two ways of estimating risk: either capital market measures of risk (see e.g. Saunders, et al. (1990); Konishi and Yasuda (2004), (Acharya *et al.* 2012)) or accounting based risk measures. Since only some banks are listed (and none of the savings banks), we cannot use capital market measures and we therefore derive risk proxies from the balance sheets. Besides the financial statements, we also have information on those banks that went into financial distress during the period 1985 to 1995 from Mølgaard (2003). Over our sample period 1985 to 1990, we have sufficient data for our risk measures for 33 institutions in financial distress.

We estimate risk using the following three step procedure. First, we construct a set of potential risk proxies based on the annual reports. Second, we use a logistic model with a binary variable indicating distress to identify the measures that can act as proxy for distress risk. These individual measures are then used in the difference-in-difference analysis. Third, we estimate a logistic model with a binary variable indicating distress as the dependent variable and all the identified risk proxies from step 2 as explanatory variables. The predicted values from this model are then used as a composite measure of risk, i.e. the D-score.

We propose a set of risk measures from the financial statements of the banks. Besides using economic intuition and the existing literature, we also test if these measures do indeed act as proxy for risk. The basic idea is that any proxy for risk should have predictive power with respect to financial distress. We therefore estimate the following model to find a set of risk measures to be used in the analysis of risk behavior around the introduction of deposit insurance:

$$Distress_{it} = \beta_0 + \beta_1 \ln TA_{it-1} + \beta_2 ROA_{it-1} + \beta_3 Unemp_{it-1} + \beta_4 NBRate_{it-1} + \beta_5 Intlong_{it-1} + \beta_6 GDP_{it-1} + \beta_7 Risk^j_{it-1} + \varepsilon_{it} \quad (1)$$

Where $Distress_{it}$ is a binary variable of 1 if the bank is in financial distress, 0 otherwise.[22] $Risk^{j}_{it-1}$ is the individual proxy for risk, "j", derived from the annual reports and presented in Table 3A. The size of the bank, measured by the logarithm of assets, is included as a control variable. Prior research shows that large banks lend a greater fraction of their assets than the small banks do, but research also suggests that large and small banks serve different borrowers. The small banks tend to lend more to small and less established companies based on soft information, whereas larger banks tend to lend more to large and well established firms (Thakor and Boot (2008)). Generally, large banks are more diversified than smaller banks, but Demsetz and Strahan (1997) find that large bank holding companies use their advantage of diversification to engage more in risky, potentially high return lending. The return on assets (ROA) is included in the model to capture the effect that institutions with low earnings are more likely to go into financial distress. Finally, we also include macroeconomic variables which may have an effect on bank behavior: the rate of unemployment (*Unemp*), the banks' interest rate at the Danish National Bank (*NBRate*), the ten year interest rate on government bonds (*IntLong*) and gross domestic product (*GDP*). We estimate a logit model for each risk measure over the period 1985 to 1990.

Please insert Tables 3A and 3B here.

As expected, Table 3B shows that the ratio of loans to deposits is significant, i.e. the size of the loan portfolio increases the default risk of the financial institution. Likewise, the ratio of equity to assets is significant, showing that an increase in the ratio reduces the probability of default, which is also expected.

In Denmark, most mortgage financing is done using mortgage backed bonds issued by specialized mortgage institutions.[23] The bonds are traded on the stock exchange, and they are reported at market value in the bank's annual report. The majority of mortgage bonds are fixed rate and issued with a long maturity. Mortgage bonds have very little default risk since no mortgage institution has defaulted since

[22] Banks in distress are obtained from Mølgaard (2003). Eigil Mølgaard was director of the Supervisory Authority from 1988 to 1996. He lists all banks and savings banks that closed due to acquisitions and/or financial distress during the period from 1985 to 1995 (Mølgaard (2003) Fig. 2, p. 64). Hence, our sample is limited to this period only.

[23] We also see *building loans* and *mortgage loans* on banks' financial statement because while building a house, customers obtain a building loan which afterwards they may (partly) convert to a mortgage loan in a bank. The majority of mortgage loans in Denmark are, however, placed in specialized mortgage institutions.

the origin of the mortgage system in 1797. Hence, the primary risk from these bonds is the interest rate risk. Thus, the higher the holdings of bonds, the higher are the capital gains and the losses caused by changes in interest rates. Because the holding of mortgage bonds and other financial assets leads to capital gains and losses, we also include the squared capital gains and losses to total assets, $(Cap.GL/TA)^2$, corresponding to the volatility of investments. Contrary to expectations (Lepetit, et al. (2008); Cebenoyan and Strahan (2004)), the coefficient on *Bonds/TA* is negative and, thus, high investments in bonds reduce the risk of distress. Similarly, $(Cap.GL/TA)^2$ is also significantly negative for the full sample but significantly positive for large institutions.[24] These findings are probably a period specific result since the long interest rate on government bonds fell from nearly 12% to 9% over the sample period, which led to capital gains to financial institutions holding these bonds.

The four variables of deposit (short, long, special and foreign deposits over total loans) measure the funding risk. Holding deposits with long maturity (deposits with maturity of more than 12 months and special deposits) decreases the risk of financial distress by reducing the funding risk. Wheelock (1992) finds that the lower the variables surplus to loans, bonds to assets, reserves to deposits and deposits to assets, the higher is the likelihood of bank failure, based on an analysis of voluntary deposit insurance in Kansas in the 1920s, and this is somewhat consistent with our results. Loan loss provisions are also significantly positive. An increase in loan loss provisions is a sign of risky behavior because increased investments in risky projects result in an increase in LLP (Lepetit, et al. (2008)). From the measures for different types of loans, only the ratios bills of exchange to total loans and building loans to total loans are significant.

We use the *Ln(Z-score)* as a measure of default risk ((Laeven & Levine 2009)). The *Z-score* is given by *(ROA+Equity/TA)/s(ROA)*, where *s(ROA)* is the standard deviation of return on assets. A higher *Z-score* indicates that the financial institution is more stable. Since the *Z-score* is highly skewed, the natural logarithm is used. Contrary to expectations, in Table 3B, the coefficient is positive and significant.

[24] For small institutions, it appears that $(Cap.GL/TA)^2$ has a negative coefficient, suggesting that these institutions used financial instruments to hedge against risk whereas the large institutions used them for speculative purposes.

Based on the results in Table 3B, we have identified the following significant proxies for risk: total loans to total deposits (*Loans/Dep.*), equity to total assets (*Equity/TA*), bonds to total assets (*Bonds/TA*), deposits with maturity more than 12 months to total loans (*LongDep./Loans*), special deposits to total loans (*SpecialDep./Loans*), loan loss provisions to total loans (*LLP/Loans*), gains and losses on foreign currency to total assets (*GL FX/TA*), bills of exchange to total loans (*BillsExc./Loans*), building loans to total loans (*B.Loans/Loans*), the square of capital gains and losses to total assets (*(Cap.GL/TA)*^{2}) and the *Z-score*.

Next, we use the eleven risk proxies identified in Table 3B as explanatory variables and estimate a logistic model with a binary dependent variable indicating distress. The predicted values from this model are used as a composite measure of risk for each individual institution. Specifically, we estimate the following logistic regression:

$$Distress_{it} = \beta_0 + \beta_1 \ln TA_{it-1} + \beta_2 ROA_{it-1} + \beta_3 Unemp_{it-1} + \beta_4 NBRate_{it-1} + \beta_5 Intlong_{it-1} + \beta_6 GDP_{it-1} + \boldsymbol{\beta}^{\mathbf{1}}\mathbf{Risk}^{\mathbf{j}}_{\mathbf{it\text{-}1}} + \varepsilon_{it} \quad (2)$$

Where ***Risk*** contains the eleven proxies identified in Table 4. The predicted probabilities from the model are used as an aggregate risk measure for the individual banks, denoted as the *D-score*.

Please insert Table 4 here.

In Table 4, the signs of the variables are mainly consistent with the univariate analysis in Table 3B, the *Z-score* now has the expected sign. Given that the risk variables are somewhat correlated, some of the variables are insignificant in the multivariate analysis compared with the univariate analysis. Given that the objective of the model is to derive a measure of expected distress and not an analysis of the individual risk variables, we leave the insignificant variables in the model.

Please insert Table 5 here.

In Table 5, we show mean values of the estimated probability of financial distress for the different size groups of commercial banks and savings banks. Based on this aggregate measure of risk, we find that on average small commercial banks are most risky, whereas small savings banks are the ones with the lowest risk. The predictions from the model are used as an aggregate measure of risk in the analyses, the *D-score*.

4.0. Research Design

The primary interest of this study is to test whether commercial banks changed their risk-taking behavior after the introduction of deposit insurance. We use a difference-in-difference approach to test this by exploiting the fact that Danish commercial banks and savings banks have different incentives to undertake risk due to their different ownership structure.

In principle, the difference-in-difference approach should be based on a sample of (comparable) financial institutions where one sub-sample is randomly assigned to a deposit insurance scheme (i.e. the treatment group) whereas the other sub-sample is not (i.e. the control group). This is, of course, not possible and we therefore use savings banks as the control group since they have no incentive to increase risk due to their ownership structure. The two sets of institutions operate in the same market under the same set of regulation and only differ with respect to ownership structure and history. We then test if commercial banks (the treatment group) increased their risk after the introduction of deposit insurance compared to savings banks. All analyses are carried out on the full sample[25] as well as on both large institutions (size groups 1 and 2) and small institutions (size group 3). Large institutions are interesting because if these banks increase risk, it may result in systemic risk, which has consequences for the whole banking industry. However, since the large banks are mostly commercial banks, we also show the results based on small institutions separately because the commercial banks and the savings banks are more comparable in this group.

[25] Due to the lack of banks in the "very small" group (group 4), these institutions are dropped from the analyses.

The difference-in-difference test is undertaken using a multivariate regression model with unbalanced panel data to analyze whether deposit insurance has an effect on bank risk-taking while controlling for macroeconomic factors (contained in the vector $\boldsymbol{X_t}$). The main model of analysis is the following:

$$Risk_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 Bank_{it} + \beta_3 Post_{it} \times Bank_{it} + \beta' \mathbf{X} + \varepsilon_{it} \quad (3)$$

Where *Post* is a dummy variable with the value of 1 if t > 1987 and *Bank* is a dummy variable equal to 1 if the institution is a commercial bank. **X** is a matrix of external macro variables: the rate of unemployment (*Unemp*), the banks' interest rate at the Danish National Bank (*NBRate*), the ten year interest rate on government bonds (*IntLong*) and gross domestic product (*GDP*). The main variable parameter of interest is PostxBank.

5.0. Results

Please insert Table 6 here.

Table 6 shows the results for the univariate difference-in-difference analysis. The variable of interest, *Post×Bank*, is significantly negative for bonds to assets for the full sample. This implies that the bond holdings of commercial banks are significantly lower than for savings banks after the introduction of deposit insurance. However, recall from Table 3B that an increase in bonds decreases the risk, which means that commercial banks increase their risk relative to savings banks, supporting the hypothesis of moral hazard. The ratio of gains and losses on foreign currency to total assets (*GL F X/T A*) is positive, which also suggests a higher level of risk-taking of commercial banks relative to savings banks after the introduction of deposit insurance. The ratio long deposits to total loans is significantly positive. Thus, the banks have increased their holdings of this type of loans compared to savings banks, but an increase in this type of loans decreases the risk of the banks, i.e. rejecting the hypothesis of moral hazard. The decrease in *LLP/Loans* similarly implies a lower level of risk-taking of commercial banks relative to savings banks.

From a regulatory point of view, we are especially interested in testing if the introduction of deposit insurance increases the systemic risk, and therefore we also focus on the largest banks in the sample. For large systemic institutions, none of the coefficients on the interaction term are significant and thus we reject that moral hazard is an issue for these banks. For the small institutions, where we have a better match between the number of commercial and savings banks in the sample, we find that the coefficient on *Post×Bank* is negative and significant for the bond ratio and positive for the ratio of gains and losses on foreign currency to total assets, which suggests an increased risk for commercial banks relative to savings banks.

Post tests the difference between the risk before and after the introduction of deposit insurance for savings banks. After controlling for bank size and macro-economic conditions, we see that the savings banks increased their ratio of bonds to assets by 0.159. The difference between the pre and the post period for commercial banks is captured by $\beta_1 + \beta_3$; hence, commercial banks did not increase as much as savings banks (a total effect of 0.104 higher bond to asset ratio).

The coefficient on *Bank* shows the difference between commercial banks and savings banks in the pre-deposit insurance period. We find that commercial banks were more risky than savings banks, which is not all that surprising considering the historical difference between these two types of banks. Recall that the difference-in-difference approach shows the difference between commercial banks and savings banks after controlling for these general differences between the two types of banks.

Based on the full sample, we find no consistent evidence in the univariate analysis of commercial banks taking higher risk after the introduction of deposit insurance compared to savings banks, hence we cannot reject our H0 hypothesis. The analysis on the small banks separately provides some indication of higher risk-taking for commercial banks relative to savings banks, and next we therefore test the effect on the aggregate measure of risk, the D-score.

Please insert Table 7 here.

The difference-in-difference analysis based on the composite measure of risk, the *D-score*, is presented in Table 7. This analysis confirms that neither savings banks nor commercial banks increased risk after the introduction of deposit insurance regardless of size of the inbstitutions.

6.0. Robustness Check

The analyses show that regardless of the size of the banks, commercial banks did not increase their risk relative to savings banks after the introduction of deposit insurance, despite the inherent moral hazard in a deposit insurance scheme. Next, we perform two sets of robustness tests. First, we test if corporate customers in commercial banks have easier access to capital than customers in savings banks in the Post period, assuming that commercial banks will invest in high risk projects (i.e. increase lending) if they change their risk behavior. Second, we test if the results are dependent on our definition of savings banks, in particular focusing on the savings banks that changed to commercial banks.

6.1. Lending to Corporate Customers

Signs of moral hazard may be found in changes in lending because more risky banks will invest more in risky projects and consequently corporate customers will obtain funding for new projects more easily. Therefore, we look at the capital structure of corporate bank customers and expect that firms financed by commercial banks will increase their debt (including both bank and non-bank borrowing) to equity ratio more than corporate customers in savings banks. An increase in the debt to equity ratio of firms will increase the credit risk of the banks, depending on the collateral and priority of bank debt.

Our data on Danish companies is a hand-collected sample from Greens Handbooks from 1983 to 1993.[26] The data contains key variables from financial statements: revenue, earnings before and after tax, extra-

[26] Since 1883, Greens Handbooks have collected information on ownership structure, financial statements and board members for Danish firms.

ordinary items, totalassets, debt, equity, dividends and share capital. Additionally, the data includes the name of the bank connection. This information makes it possible to test if there is a difference in the leverage of firms having either a commercial bank or a savings bank before and after the introduction of deposit insurance. Increased willingness to take risk is assumed to translate into larger loans tocustomers.

Please insert Table 8 here.

As seen from Table 8, the number of firms having either a commercial bank or a savings bank has not changed significantly during the period, probably due to relationship banking, resulting in a long-term relation. But the number of firms with more than one bank relation has dropped significantly. This may be a result of the number of acquisitions by financial institutions, making these larger and therefore better capable of handling large customers alone.

Please insert Table 9 here.

Descriptive statistics of the firms in the sample can be seen in Table 9. Overall, the table shows little difference between the customers of commercial banks and savings banks. However, the *Debt/Equity* ratio increases for customers in commercial banks after the introduction of deposit insurance, whereas there is a marked decrease for the customers in savings banks.

The research field of capital structure is enormous and factors found to affect the capital structure of firms are numerous. Although research has identified a large number of variables which potentially affect capital structure, there are relatively few general determinants of capital structure ((Harris & Raviv 1991)). (Rajan & Zingales 1995) test if variables known to affect the capital structure of American firms also provide significant results when applied to international data. The variables which they find to affect capital structure are fixed to total assets, market to book values, size (measured as log sales) and profitability (measured as EBITDA over book value of total assets). The dependent variable is debt to book and market capital. Because of limited data on firms, the variables used in this study are size (measured as the logarithm of assets) growth in total assets and profitability as the ratio of P/L before tax to total assets.

The empirical model is estimated with OLS using clustered standard errors and is stated as follows.

$$\left(\frac{D}{E}\right)_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 Bank_{it} + \beta_3 Post_{it} \times Bank_{it} + \beta_4 \ln \mathrm{TA}_{it} + \beta_5 Roa_{it} + \beta_6 \Delta TA_{it} + \beta_7 NBRate_t + \beta_8 Unemp_t + \beta_9 Intlong_t + \beta_{10} GDP_t + \beta_{11}\left(\frac{D}{E}\right)_{it-1} + \varepsilon_{it} \quad (1.8)$$

Size is in general positively related to leverage, which may be explained by lower information asymmetry of larger compared to smaller firms ((Rajan & Zingales 1995)). Although size is found to be correlated with leverage, there is no clear understanding of why this is the case. Profitability and growth are expected to be negatively related to leverage. The lagged debt to equity ratio (β_{11}) comes from a partial adjustment model which states that the level of debt in year *t* is dependent on the level of debt in year *t-1* and measures the speed of adjustment, satisfying $0 < \beta_{11} < 1$.

We test the capital structure of corporate customers in commercial banks versus savings banks by focusing on the difference-in-difference estimator, β_3, which is expected to be zero.

Please insert Table 10 here.

Table 10 presents the results of the analysis of firms' capital structure. We see that the debt to equity ratio of corporate customers in commercial banks is higher than for customers in savings banks after the introduction of deposit insurance, (*Post*×*Bank*), for the full sample and for the large banks, but the results are insignificant. Since commercial banks do not increase lending to corporate customers compared to savings banks, this analysis supports the H_0 hypothesis, i.e. that commercial banks did not change behavior as a consequence of the introduction of deposit insurance.

6.2. Definition of Savings Banks

Our set-up is contaminated by the ability of savings banks to convert to commercial banks. When deposit insurance was introduced in 1988, regulation made it possible for a savings bank to convert to joint-stock ownership, i.e. to become a commercial bank. During the period 1988 to 1990, seven savings banks converted to commercial banks.[27] Although savings banks were allowed to convert to commercial banks, the guarantors and depositors were not allowed to benefit from the transaction.[28] A savings bank could also convert to a commercial bank by being acquired by a commercial bank. When a savings bank was acquired by a commercial bank or converted to a commercial bank, the equity component of the savings bank balance was transferred in the form of shares in the commercial bank to a public fund supporting charitable causes in society.

In the paper so far, we coded savings banks as savings banks and if they converted to commercial banks then they were subsequently coded as commercial banks. The underlying argument for this is based on ownership and control. The guarantors and depositors controlled the savings banks and although they may have benefitted slightly from a conversion to a commercial bank, we assume that they would not allow for an increase in risk and therefore a decrease in the value of their deposits and guarantee bonds prior to the conversion.

However, it is possible to argue that the savings banks that converted to commercial banks should be treated as banks through the whole period. The political process leading up to the changes in the law (described in (Hansen 2001) chapters 14 and 15) indicates that during the eighties two types of savings banks evolved: one based on the old principles of community service and one with a desire for growth.[29] The growth oriented savings banks were constrained by their ability to raise external capital and these savings bank therefore argued for the need of obtaining additional capital. In response to this, Sparekasseforeningen (association of savings banks) in 1984 started lobbying for savings banks

[27] 1989: SDS, Bikuben, Sparekassen Sønderjylland and Skive Sparekasse. 1990: Sparekassen Fåborg, Sparekassen Nordjylland and Sparekassen Sydjylland.
[28] The conversion had to be approved by the guarantors and/or the depositors. It is not clear how these "bondholders" were convinced to become shareholders unless they received a pay-off. We have not been able to ascertain how this was done in practice, but it seems that the guarantors received 10-15% overpayment on their certificates.
[29] This book is a history of savings banks from 1965 to 1990 written by a professional historian at University of Southern Denmark.

being permitted to raise external capital, one possibility being to allow savings banks to convert to shareholder ownership. For our study the question is: the savings bank that later converted to commercial banks, how did they behave in the period leading up to the change in laws (the introduction of deposit insurance and the allowance of savings banks to change to commercial banks)? As discussed above regarding this issue, at least in theory, depositors and guarantors controlled the savings banks and pursuing growth and increased risk was not in their interest. On the other hand, these institutions had spent a fair amount of resources lobbying for changes in the law, and in addition some of them had opened foreign branches in anticipation of future growth indicating that they may have behaved more like commercial banks compared to savings banks prior to the introduction of the laws. One interpretation of this is that in practice the depositors and guarantors did not control the savings bank, and the savings banks did not operate in their interests. To deal with these issues, we re-run the empirical analysis in the following way. (1) Savings banks that converted to commercial banks are dropped entirely from the sample. (2) Savings banks that converted to commercial banks are coded as commercial banks before the introduction of deposit insurance (3) The bank dummy variable in the regressions is treated as an endogenous variable and the model is re-estimated using instrumental variables.

Please insert Tables 11 and 12 here.

Tables 11 and 12 show the results from the difference-in-difference analysis for the composite risk measure, *D-score*, when the savings banks that converted to commercial banks are dropped from the sample and when they are coded as banks through the whole sample period. As seen, the *PostxBank* variable is not significant regardless of size, confirming the previous results.

When deposit insurance was introduced in 1988, regulation made it possible for a savings bank to convert to joint-stock ownership, i.e. to become a commercial bank. This means that from this point in time, the status of the institution as either a commercial bank or a savings bank is endogenous since the savings banks do not choose to convert randomly. Unless the shareholders in a commercial bank are willing to donate their shares to the bank, it is not possible for a commercial bank to convert to a savings

bank and still satisfy the capital requirements. Thus, the variable *Bank* is only endogenous for savings banks after 1988. During the period 1988 to 1990, seven savings banks converted to commercial banks.[30]

To deal with the endogeneity problem, we use an instrumental variables approach. The estimation procedure is to treat the *Bank* variable as exogenous until 1988 and endogenous for savings banks from 1988 as, until 1988, savings banks had no incentive to behave as commercial banks since they had no shareholders. We therefore apply a two stage least squares model from 1988. As stated above, the commercial banks could not convert to savings banks, hence the *Bank* variable is exogenous for commercial banks during the full period.

To perform the analysis, we need to identify appropriate instrumental variables which are correlated with the decision to convert to a bank, but uncorrelated with the explanatory variable in the main model, *Risk*. We use the existence of a foreign branch in 1982, the growth in assets from 1981 to 1983 and the size in 1982. All instruments are dated before the discussion started in the Savings Banks Association about the possibility of converting, i.e. before the political and the lobby process to change the law even started.[31] The existence of a foreign branch indicates that the savings bank had a desire for growth and therefore a desire to become a bank. Similarly, the savings banks with high growth and high levels of total assets in 1982 were likely to be more interested in converting. Naturally, bank growth and size are likely to be highly correlated with the explanatory variable *Risk*, but since the first stage regression is estimated over the period 1988-1990, the correlation between bank growth and size in 1982 and *Risk* in 1988 is low. Given that the instrumental variables are dated before the debate started, they are considered exogenous.

The first step regression is given as follows.

$$SwitchBank_{it} = \beta_0 + \beta_1 Branch_{it} + \beta_2 Growth + \beta_3 \ln TA_{it} + \beta_4 Y1989 + \beta_5 Y1990 + \varepsilon_{it}$$

[30] 1989: SDS, Bikuben, Sparekassen Sønderjylland and Skive Sparekasse. 1990: Sparekassen Fåborg, Sparekassen Nordjylland and Sparekassen Sydjylland.
[31] According to Hansen (2001, p.271), the idea arose at some time in 1984 in the Association of Savings Banks.

Where *SwitchBank* is an indicator variable of 1 for those savings banks that converted to commercial banks after 1988, 0 otherwise,[32] Branch is an indicator variable of 1 if the savings bank had a foreign branch in 1982, 0 otherwise, Growth is the average yearly growth in total assets from 1981 to 1983 and lnTA is the logarithm of total assets in 1982. Additionally, we have included year dummies for 1989 and 1990. The model is estimated as a probit model over the period 1988-1990, and we convert the predicted probabilities from the model to binary variables at the median.

Please insert Table 13 here.

The results from the first stage regression are shown in Table 13. We find that only the size of the savings bank in 1982 significantly explains the choice of converting to a commercial bank after 1988. Clearly the instruments are not particularly strong, which casts doubts on the results from this procedure.

For the second stage estimation, the indicator variable *Bank* is constructed in the following fashion. If the institution is a commercial bank or the year is before 1988, then the variable *Bank* is exogenous, hence the same as in the OLS model above (see Equation 3). The potential endogeneity for savings banks arises after 1988 only because it is not random which savings banks choose to convert to commercial banks. For savings banks we therefore replace the variable *Bank* with the predicted values from the first stage regression. The interaction term $Post \times Bank$ is then calculated using the instrument for *Bank*, and Equation 3 is re-estimated using OLS and clustered standard errors.

Please insert Table 14 here.

The results of the analyses based on the aggregate measure of risk, the *D-score*, confirm the main result that commercial banks did not increase risk relative to savings banks after the introduction of deposit insurance (see Table 14). In the analysis of corporate customers, we also have an endogeneity problem

[32] Recall that this sample only includes savings banks since commercial banks are not endogenous as they cannot convert to savings banks.

with the dummy variable *Bank*. This analysis is therefore re-run using our IV estimates of the dummy variable *Bank.* The analysis, not shown, shows no significant difference between corporate customers in commercial banks relative to customers in savings banks, supporting our previous results of no risk shifting in an environment with high capital requirements and firm closure policy.

7.0. Conclusion

During the 1980s, Denmark operated a universal banking system characterized by high capital requirements, firm closure policy of institutions in distress and liquidity requirements. Although the financial institutions faced strong capital regulation they were free to invest in among others stocks, corporate bonds, real estate and operate investment banking operations subject to individual exposure requirements. Thus they could undertake risky investments but the high capital requirements and firm closure policy ensured that tax payers did not pay for the high risk. Denmark introduced deposit insurance into this system and offers an opportunity for testing the moral hazard hypothesis under strong capital regulation. It is possible to test the risk shifting hypothesis because commercial banks have an incentive to perform risk shifting whereas savings banks have not and both types of institutions operated under the same set of regulation. We show that commercial banks did not increase their risk relative to savings banks in response to the introduction of the formal deposit insurance scheme. The large banks in our sample represent the systemic banks and they are, of course, interesting from a regulatory point of view. We find that the large institutions did not increase risk either, suggesting that systemic risk is not jeopardized when deposit insurance is introduced into a system with high capital requirements and a firm closure policy. These results should be of particular interest to regulators when promoting the introduction of deposit insurance across countries.

References

Acharya, S., 1996. Charter value, minimum bank capital requirement and deposit insurance pricing in equilibrium. Journal of Banking & Finance 20, 351-375

Acharya, V., Engle, R., Richardson, M., 2012. Capital Shortfall: A New Approach to Ranking and Regulating Systemic Risks. The American Economic Review 102, 59-64

Alston, L.J., Grove, W.A., Wheelock, D.C., 1994. Why Do Banks Fail? Evidence from the 1920s. Explorations in Economic History 31, 409-431

Anginer, D., Demirguc-Kunt, A., Zhu, M., 2014. How does deposit insurance affect bank risk? Evidence from the recent crisis. Journal of Banking & Finance 48, 312-321

Baldwinsson, C., Brokhattingen, F., Busck-Nielsen, K., Rasmussen, F.N., 2000. Dansk Bankvæsen. Thomson A/S, København.

Bartholdy, J., Boyle, G.W., Stover, R.D., 2003. Deposit insurance and the risk premium in bank deposit rates. Journal of Banking & Finance 27, 699-717

Bartholdy, J., Boyle, G.W., Stover, R.D., 2004. Deposit insurance and the stock market: evidence from Denmark. In: European Journal of Finance, pp. 567-578. Routledge

Bernard, V.L., Merton, R.C., Palepu, K.G., 1995. Mark-to-Market Accounting for Banks and Thrifts: Lessons from the Danish Experience. Journal of Accounting Research 33, 1-32

Calomiris, C.W., Jaremski, M.S., 2016a. Deposit Insurance: Theories and Facts. Annual Review of Financial Economics 8, 97-120

Calomiris, C.W., Jaremski, M.S., 2016b. Stealing Deposits: Deposit Insurance, Risk-Taking and the Removal of Market Discipline in Early 20th Century Banks. National Bureau of Economic Research Working Paper Series No. 22692

Carapella, F., Giorgio, G.D., 2004. Deposit Insurance, Institutions, and Bank Interest Rates. Transition Studies Review 11, 77-92

Carr, J., Mathewson, F., Quigley, N., 1994. Ensuring Failure: Financial System Stability and Deposit Insurance in Canada. C.D. Howe Institute, Toronto.

Carr, J., Mathewson, F., Quigley, N., 1995. The Economics of Canadian Deposit Insurance. In: Department of Economics Research Reports, 9502. University of Western Ontatioy, Department of Economics, University of Western Ontario.

Chan, Y.-S., Greenbaum, S.I., Thakor, A.V., 1992. Is Fairly Priced Deposit Insurance Possible? Journal of Finance 47, 227-245

Chernykh, L., Cole, R.A., 2011. Does deposit insurance improve financial intermediation? Evidence from the Russian experiment. Journal of Banking & Finance 35, 388-402

Cole, R.A., 1993. When Are Thrift Institutions Closed? An Agency-Theoretic Model. Journal of Financial Services Research 7, 283-307

Cordell, L.R., Donald, G.D.M., Wohar, M.E., 1993. Corporate Ownership and the Thrift Crisis. Journal of Law and Economics 36, 719-756

Cull, R., Senbet, L.W., Sorge, M., 2005. Deposit Insurance and Financial Development. Journal of Money, Credit & Banking (Ohio State University Press) 37, 43-82

DeLong, G., Saunders, A., 2011. Did the introduction of fixed-rate federal deposit insurance increase long-term bank risk-taking? Journal of Financial Stability 7, 19-25

Demirgüç-Kunt, A., Detragiache, E., 2002. Does deposit insurance increase banking system stability? An empirical investigation. Journal of Monetary Economics 49, 1373-1406

Demirgüç-Kunt, A., Kane, E.J., 2002. Deposit Insurance around the Globe: Where Does It Work? The Journal of Economic Perspectives 16, 175-195

Demirgüç-Kunt, A., Kane, E.J., Laeven, L., 2008. Determinants of deposit-insurance adoption and design. Journal of Financial Intermediation 17, 407-438

Diamond, D.W., Dybvig, P.H., 1983. Bank Runs, Deposit Insurance, and Liquidity. The Journal of Political Economy 91, 401-419

Duan, J.-C., Moreau, A.F., Sealey, C.W., 1992. Fixed-rate deposit insurance and risk-shifting behavior at commercial banks. Journal of Banking & Finance 16, 715-742

Esty, B.C., 1997. Organizational form and risk taking in the savings and loan industry. Journal of Financial Economics 44, 25-55

Fraser, D.R., Zardkoohi, A., 1996. Ownership structure, deregulation, and risk in the savings and loan industry. Journal of Business Research 37, 63-69
Freixas, X., Rochet, J.-C., 1998. Fair pricing of deposit insurance. Is it possible? Yes. Is it desirable? No. Research in Economics 52, 217-232
García-Marco, T., Robles-Fernández, M.D., 2008. Risk-taking behaviour and ownership in the banking industry: The Spanish evidence. Journal of Economics and Business 60, 332-354
Goodman, L.S., Santomero, A.M., 1986. Variable-rate deposit insurance: A re-examination. Journal of Banking & Finance 10, 203-218
Gropp, R., Gruendl, C., Guettler, A., 2014. The Impact of Public Guarantees on Bank Risk-Taking: Evidence from a Natural Experiment*. Review of Finance 18, 457-488
Gropp, R., Vesala, J., 2004. Deposit Insurance, Moral Hazard and Market Monitoring. Review of Finance 8, 571-602
Grossman, R.S., 1992. Deposit Insurance, Regulation, and Moral Hazard in the Thrift Industry: Evidence from the 1930's. The American Economic Review 82, 800-821
Hansen, P., 2001. Da Sparekasserne Mistede Deres Usjyld. Odense Universitetsforlag.
Harris, M., Raviv, A., 1991. The Theory of Capital Structure. The Journal of Finance 46, 297-355
Hovakimian, A., Kane, E.J., 2000. Effectiveness of Capital Regulation at U.S. Commercial Banks, 1985 to 1994. The Journal of Finance 55, 451-468
Hovakimian, A., Kane, E.J., Laeven, L., 2003. How Country and Safety-Net Characteristics Affect Bank Risk-Shifting. Journal of Financial Services Research 23, 177-204
Iannotta, G., Nocera, G., Sironi, A., 2007. Ownership structure, risk and performance in the European banking industry. Journal of Banking & Finance 31, 2127-2149
Ioannidou, V.P., Penas, M.F., 2010. Deposit insurance and bank risk-taking: Evidence from internal loan ratings. Journal of Financial Intermediation 19, 95-115
Jensen, K.B., Noergaard, J., 1976. Bank- og sparekasseloven: med kommentarer. Juristforbundet, Kbh. Juristforbundet, København.
Justesen, L.G., 2015. Empirical Banking. Aarhus University.
Kam Hon, C., 2011. DEPOSIT INSURANCE AND BANKING STABILITY. CATO Journal 31, 99-117
Kane, E.J., 1989. The Unending Deposit Insurance Mess. Science 246, 451-456
Karels, G.V., McClatchey, C.A., 1999. Deposit insurance and risk-taking behavior in the credit union industry. Journal of Banking & Finance 23, 105-134
Laeven, L., 2002. International evidence on the value of deposit insurance. The Quarterly Review of Economics and Finance 42, 721-732
Laeven, L., Levine, R., 2009. Bank governance, regulation and risk taking. Journal of Financial Economics 93, 259-275
Lambert, C., Noth, F., Schüwer, U., 2015. How do insured deposits affect bank risk? Evidence from the 2008 Emergency Economic Stabilization Act. Journal of Financial Intermediation
Marcus, A.J., Shaked, I., 1984. The Valuation of FDIC Deposit Insurance Using Option-Pricing Estimates. Journal of Money, Credit and Banking 16, 446-460
McKenzie, J.A., Cole, R.A., Brown, R.A., 1992. Moral Hazard, Portfolio Allocation, and Asset Returns for Thrift Institutions. Journal of Financial Services Research 5, 315-339
Merton, R.C., 1977. An analytic derivation of the cost of deposit insurance and loan guarantees An application of modern option pricing theory. Journal of Banking and Finance 1, 3-11
Mølgaard, E., 2003. Vagthund og Syndebuk. Personlig beretning om finanskrisen i Danmark 1987-1995. Børsens Forlag A/S, Copenhagen.
Nier, E., Baumann, U., 2006. Market discipline, disclosure and moral hazard in banking. Journal of Financial Intermediation 15, 332-361
Pozdena, R.J., 1992. Danish banking: Lessons for deposit insurance reform. Journal of Financial Services Research 5, 289-298
Rajan, R.G., Zingales, L., 1995. What Do We Know about Capital Structure? Some Evidence from International Data. The Journal of Finance 50, 1421-1460
Santomero, A.M., 1984. Modeling the Banking Firm: A Survey. Journal of Money, Credit and Banking 16, 576-602
Schenck, N.A., Thornton, J.H., 2016. Charter values, bailouts and moral hazard in banking. Journal of Regulatory Economics 49, 172-202
Tilsynet med banker og sparekasser, 1984. Banker og Sparekasser 1984. Beretning om bankers og sparekassers virksomhed.

Wheelock, D.C., 1992. Deposit Insurance and Bank Failures: New Evidence from the 1920s. Economic Inquiry 30, 530
Wheelock, D.C., Wilson, P.W., 1995. Explaining Bank Failures: Deposit Insurance, Regulation, and Efficiency. The Review of Economics and Statistics 77, 689-700

Table 1: Number of commercial and savings banks by size in the sample

Data is from the annual reports of the Supervisory Authority, 1985-1990, and the size categories are based on the definitions in these reports. Institutions with errors in the annual reports are omitted from the sample for that year and the total number of institutions in the sample therefore differs slightly from the number provided in the annual reports.

	Commercial banks				Savings banks				
Year	Large	Medium	Small	Total	Large	Medium	Small	Very Small	Total
1985	6	16	50	72	2	11	79	55	147
1986	6	14	53	73	2	11	82	49	144
1987	6	14	56	76	2	10	81	47	140
1988	6	12	54	72	2	9	41	83	135
1989	8	12	53	73	0	5	43	76	124
1990	2	11	58	71	0	1	44	71	116

Table 2: The balance sheet composition before and after deposit insurance

Pre is the average of the years 1985, 1986 and 1987 and Post is the average of the years 1988, 1989 and 1990. Large is group 1 and 2 banks, and Small is group 3 banks. Data is from the annual report of the Supervisory Authority, 1985-1990.

	Commercial banks				**Savings banks**			
	Large		Small		Large		Small	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	In % of total assets							
Cash	0.94	1.37	0.86	0.83	0.81	1.00	0.63	0.74
Dep. central bank	0.63	2.05	0.35	1.09	0.49	0.84	0.45	0.45
Dep. domestic banks	4.45	4.78	6.63	4.97	6.04	5.29	5.77	5.51
Dep. foreign banks	13.00	13.56	1.70	0.90	7.34	3.24	0.05	0.03
Inv. in debt securities	16.94	20.93	19.94	24.37	16.31	20.90	25.10	30.53
Inv. in stocks	3.21	2.75	3.66	2.87	2.27	2.02	2.32	2.33
Loans	42.12	38.07	45.66	41.19	50.72	48.81	45.15	44.32
Fixed assets	1.41	1.46	1.93	2.07	1.96	2.19	2.88	2.72
Other assets	17.34	15.06	19.35	21.79	14.06	15.72	17.66	13.36
	In % of total liabilities							
Dep. (<1 month)	24.27	24.73	25.05	22.72	25.98	23.41	29.35	24.55
Dep. (<12 months)	7.20	10.17	9.55	9.77	8.33	11.11	12.5	12.66
Dep. (> 12 months)	1.14	2.45	3.89	7.24	2.54	7.19	5.68	14.25
Other dep.	12.86	9.36	11.71	8.10	14.37	12.29	14.77	12.54
Debt to domestic	4.63	8.48	12.58	15.71	6.58	8.04	4.14	6.18
Debt to foreign banks	23.51	20.67	4.29	2.28	18.41	10.41	0.78	0.00
Guarantees issued	12.43	11.07	14.63	18.4	8.57	10.34	13.60	11.08
Other liabilities	6.01	5.00	6.52	5.19	6.22	7.89	6.19	5.50
Subordinate debt	2.00	1.93	1.53	1.22	2.73	2.36	1.96	1.99
Equity	5.94	6.14	10.24	9.36	6.28	6.96	11.03	11.24

Table 3A: Test of risk proxies

The definition of the risk proxies are provided below. The data is obtained from various issues of the reports issued by the supervisory authorities, (Tilsynet med banker og sparekasser, various years).

Risk proxies	Definition of risk proxies
TA	Total assets in the institution
Loans	Total loans in the institution
Loans/TA	
Loans/Dep.	Dep is the total deposits in the bank
Equity/TA	*Equity* is the sum of capital and reserves
Bonds/TA	Bonds is total bonds held by the institution
Mortgage deeds/TA	
ShortDep./Loans	*ShortDep.* is deposits with maturities of less than 1 month
LongDep./Loans	*LongDep.* is deposits with maturities of more than 12 months
SpecialDep./Loans	SpecialDep is special deposits.
ForeignDep./Loans	ForeignDep is deposits by foreigners.
LLP/Loans	*LLP* is loan loss provisions
GLFX/TA	*GLFX* is gains and losses on foreign currency transactions.
Cash plus dep. in banks/TA	Cask plus deposits held in domestic, foreign institutions and the central bank
Overdraft facilities/Loans	
BillsExc./Loans	*BillsExc.* is bills of exchange
B.Loans/Loans	*B.Loans* is building loans
Mortgage loans/Loans	
Other loans/Loans	
$(Cap.GL/TA)^2$	*Cap.GL* is capital gains or losses
% Change in loans	
Ln(Z-score)	Ln(Z-score) defined as (ROA+Equity/TA)/s(ROA), where s(ROA) is the standard deviation of return on assets Ln(Z-score)

Table 3B: Test of risk proxies

The following Logit model is estimated for each risk variable:

$$Distress_{it} = \beta_0 + \beta_1 \ln TA_{it-1} + \beta_2 ROA_{it-1} + \beta_3 Unemp_{it-1} + \beta_4 NBRate_{it-1} + \beta_5 Intlong_{it-1} + \beta_6 GDP_{it-1} + \beta_7 Risk^j_{it-1} + \varepsilon_{it}$$

where *distress* is binary variable for distress. *TA* is the total assets of bank "I" at time "t", *ROA* is the return on assets, *Unemp* is unemployment, *NBRate* is the short term interest rate, *Intlong* is the long interest rate and *GDP* is the gross domestic product in local currency. The estimates are shown for the full sample of financial institutions (groups 1, 2 and 3) as well as for large (groups 1 and 2) and small (group 3) institutions. The estimation period is from 1985 to 1990. For the definition of the risk proxies see Table 3A. Variables in bold are those selected for further analysis.

Risk variable	Full sample	Large Institutions	Small institutions
Loans/TA	2.51	1.23	2.95
Loans/Dep.	0.95***	3.34***	0.73***
Equity/TA	-17.94***	-58.78	-12.5**
Bonds/TA	-12.15***	-20.70*	-11.55***
Mortgage deeds/TA	5.30	-35.58	6.76
ShortDep./Loans	-0.40	-25.64**	-0.05
LongDep./Loans	-8.10***	-6.55	-8.85***
SpecialDep./Loans	-7.85***	-21.40**	-6.51***
ForeignDep./Loans	0.77	29.17*	0.46
LLP/Loans	26.44***	-41.14	30.91***
GL FX/TA	37.2**	297.21	-34.04
Cash plus dep. in banks/TA	-1.15	25.49***	-3.75
Overdraft facilities/Loans	1.00	-3.96	1.82
BillsExc./Loans	5.53**	17.28	5.29**
B.Loans/Loans	9.82**	-34.97	12.25***
Mortgage loans/Loans	-0.25	-17.68	0.27
Other loans/Loans	-1.83	8.47*	-3.60**
(Cap.GL/TA)^2	-3233.60***	20977.56**	-1612.09
% Change in loans	-0.01	-0.0731**	-0.0106
Ln(Z-score)	0.68***	0.18	0.58***
No. of institutions in distress	33	6	27

The symbols ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

Table 4: Estimation of the aggregate risk model

The following Logit model is estimated:

$$Distress_{it} = \beta_0 + \beta_1 \ln TA_{it-1} + \beta_2 ROA_{it-1} + \beta_3 Unemp_{it-1} + \beta_4 NBRate_{it-1} + \beta_5 Intlong_{it-1} + \beta_6 GDP_{it-1} + \boldsymbol{\beta}^{1}\mathbf{Risk}^{\mathbf{j}}_{\mathbf{it-1}} + \varepsilon_{it} \quad (1.2)$$

See Tables 3A and B for a description of the variables.

	Estimate	Std. Error	Wald stat.
Risk measures			
Loans/Dep.	2.91	1.15	6.40**
Equity/TA	-80.29	30.56	6.90***
Bonds/TA	-18.89	7.25	6.79***
LongDep./Loans	0.81	3.88	0.04
SpecialDep./Loans	-2.70	6.23	0.19
LLP/Loans	35.23	23.40	2.27
GL FX/Assets	-109.56	202.56	0.29
BillsExc./loans	2.88	11.45	0.06
B.Loans/loans	19.81	7.81	6.44**
$(Cap.GL/TA)^2$	-465.25	1443.70	0.10
Ln(Z-score)	-0.49	0.55	0.81
lnTA	-0.46	0.36	1.63
ROA	10.95	38.86	0.08
Unemp	-1.10	1.45	0.58
NBRate	2.53	2.35	1.16
IntLong	-1.06	1.15	0.84
GDP	-0.24	0.38	0.39
Constant	12.64	12.41	1.04
Somer's D			0.950
Goodman-Kruskal Gamma			0.952
Kendall's Tau-a			0.053
ROC-c			0.975

The symbols ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

Table 5: Average *D-scores*

Average of the predicted default probabilities from the following Logit model:

$$Distress_{it} = \beta_0 + \beta_1 \ln TA_{it-1} + \beta_2 ROA_{it-1} + \beta_3 Unemp_{it-1} + \beta_4 NBRate_{it-1} + \beta_5 Intlong_{it-1} + \beta_6 GDP_{it-1} + \boldsymbol{\beta}^{1}\mathbf{Risk}^{\mathbf{j}}_{\mathbf{it\text{-}1}} + \varepsilon_{it} \quad (2)$$

See Tables 3A and 3B for a description of data.

Group	Obs.	Mean	Std. dev.
Commercial banks			
Large	107	0.0357	0.1289
Small	229	0.0396	0.1411
Savings banks			
Large	52	0.0108	0.0284
Small	236	0.0193	0.0943

Large institutions are in groups 1 and 2, and small institutions are in group 3.

Table 6: Difference-in-difference analysis of individual risk measures

The difference-in-difference analysis is undertaken using the following model:

$$Risk_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 Bank_{it} + \beta_3 Post_{it} \times Bank_{it} + \beta_4 \ln TA_{it-1} + \beta_5 ROA_{it-1} + \beta_6 Unemp_{it-1} + \beta_7 NBRate_{it-1} + \beta_8 Intlong_{it-1} + \beta_9 GDP_{it-1} + \varepsilon_{it}$$

See Table 3 for a definition of the risk measures and the control variables (*LnTA*, *ROA*, *NBRate*, *IntLong* and *GDP*). *Post* is an indicator of 1 in the years after the introduction of deposit insurance, i.e. from 1988, 0 otherwise, and *Bank* is an indicator of 1 for all commercial banks, 0 otherwise. *Post×Bank* is the variable of interest and shows the effect of introducing deposit insurance for commercial banks relative to savings banks.

	Loans/ Deposits	Equity/ Assets	Bonds/ Assets	Long Dep/ Loans	Spec. Dep/ Loans	LLP/ Loans	GLFX/ Asset	BillsExc/ Loans	B.Loans/ Loans	$\left(\frac{CapGL}{Assets}\right)^2$	Z-score
					Full Sample						
Constant	0.3344	0.4315	1.2985	-0.0396	-0.0434	1.1715	-0.0118	0.0894	0.1656	0.0010	-1.3630
	(5.14)	(5.54)	(9.92)	(-0.43)	(-2.82)	(2.86)	(-2.29)	(2.09)	(5.82)	(0.60)	(-2.17)
Post	-0.0188	0.1594	0.1922	0.0810	0.0351	-0.1497	0.0025	0.0204	0.0030	0.0016	-2.9141
	(-0.79)	(5.91)	(5.09)	(1.20)	(3.96)	(-0.70)	(1.34)	(1.32)	(0.21)	(7.54)	(-11.34)
Bank	0.0226	0.0067	-0.1121	0.0110	0.0050	0.1677	0.0009	0.0297	0.0084	0.0000	0.0737
	(1.89)	(0.38)	(-3.95)	(0.31)	(2.14)	(2.72)	(2.67)	(2.35)	(1.53)	(-0.05)	(0.69)
PostxBank	-0.0068	-0.0552	0.0586	0.0079	-0.0054	0.0260	0.0020	-0.0179	-0.0030	0.0000	0.2570
	(-0.62)	(-3.23)	(1.68)	(0.10)	(-1.79)	(0.40)	(2.13)	(-1.55)	(-0.55)	(-0.11)	(1.85)

Large Institutions											
Constant	0.4001	0.4986	0.5486	0.2371	0.0277	1.2283	-0.0197	0.1537	0.1462	0.0003	-2.9224
	(2.90)	(3.77)	(3.16)	(1.72)	(0.86)	(1.54)	(-1.37)	(3.29)	(3.55)	(0.20)	(-1.60)
Post	-0.0888	0.1607	0.1216	0.1085	0.0576	-0.2664	0.0114	-0.0056	-0.0161	0.0008	-3.3562
	(-0.94)	(4.77)	(3.72)	(2.71)	(2.83)	(-1.05)	(1.25)	(-0.37)	(-1.27)	(0.95)	(-5.56)
Bank	0.0027	-0.0023	-0.0768	-0.0115	0.0007	0.0758	0.0001	-0.0181	0.0074	0.0000	0.2579
	(0.26)	(-0.10)	(-1.77)	(-0.57)	(0.34)	(0.93)	(0.10)	(-1.53)	(1.04)	(-0.25)	(1.98)
PostxBank	-0.0504	-0.0081	0.0311	-0.0026	-0.0120	-0.0325	0.0050	0.0060	0.0035	-0.0004	-0.0588
	(-1.02)	(-0.37)	(0.85)	(-0.17)	(-1.38)	(-0.47)	(0.96)	(0.58)	(0.53)	(-0.89)	(-0.19)
Small Institutions											
Constant	0.3853	0.3130	1.5816	-0.3750	-0.0791	1.3109	-0.0068	0.0137	0.1569	0.0004	-0.1538
	(3.54)	(2.47)	(6.75)	(-1.32)	(-4.05)	(2.34)	(-1.74)	(0.22)	(4.16)	(0.15)	(-0.17)
Post	-0.0028	0.1571	0.2431	0.0505	0.0251	-0.1412	0.0006	0.0231	0.0080	0.0018	-2.6314
	(-0.14)	(4.69)	(5.10)	(0.49)	(2.63)	(-0.50)	(0.55)	(1.13)	(0.42)	(8.51)	(-9.30)
Bank	0.0349	-0.0088	-0.0910	-0.0346	0.0035	0.2196	0.0015	0.0390	0.0065	-0.0001	0.2331
	(1.79)	(-0.38)	(-2.47)	(-0.60)	(1.20)	(2.54)	(2.64)	(2.31)	(0.87)	(-0.15)	(1.64)
PostxBank	-0.0053	-0.0480	0.0363	0.0573	-0.0023	-0.0031	0.0015	-0.0243	-0.0032	0.0000	0.1227
	(-0.52)	(-2.41)	(0.83)	(0.49)	(-0.65)	(-0.03)	(1.84)	(-1.48)	(-0.48)	(0.03)	(0.79)

The control variables are not shown. The model is estimated using OLS with standard errors clustered at the bank level. T statistics are given in parentheses.

Table 7: The effect of deposit insurance on *D-scores*

The following model is estimated:

$$D-score_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 Bank_{it} + \beta_3 Post_{it} \times Bank_{it} + \varepsilon_{it} \quad (2)$$

The *D-score* is the predicted default value for each institution for each year obtained from Table 5. See Table 3A for variable definitions. The model is estimated using OLS with standard errors clustered at bank level. T statistics are given in parentheses.

	Full sample	**Large institutions**	**Small institutions**
Constant	0.0131	0.0104	0.0138
	(2.54)	(1.89)	(2.19)
Post	0.0137	0.0011	0.0158
	(.95)	(.19)	(.93)
Bank	0.0219	0.0264	0.0204
	(1.86)	(1.33)	(1.43)
PostxBank	-0.0063	-0.0038	-0.0039
	(-0.31)	(-0.25)	(-0.15)

Table 8: Number of firms based on bank connection

The table shows the number of firms in the sample before (1986) and after (1993) the introduction of deposit insurance. It also includes the number of firms with multiple bank relations.

	1986	1993
Commercial bank	771	775
Savings bank	58	54
Total	**829**	**829**
Multiple bank connections	166	71

Table 9: Descriptive statistics of firms based on the bank connection

	Commercial banks				Savings banks			
	Pre		Post		Pre		Post	
Variables	Mean	Median	Mean	Median	Mean	Median	Mean	Median
lnTA	11.23	11.01	11.53	11.39	10.83	10.58	11.11	10.86
Revenue/TA	2.00	1.72	1.79	1.53	2.02	1.75	2.06	1.86
ROA	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02
Debt/Equity	24.5	9.31	29.27	9.58	26.2	7.73	16.18	6.12
Equity/TA	0.32	0.3	0.33	0.31	0.29	0.26	0.28	0.29
Profit Margin	0.05	0.04	0.04	0.02	0.03	0.03	0.03	0.02
EBT/TA	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02
Debt/TA	0.68	0.70	0.67	0.69	0.71	0.72	0.72	0.71
ROE	1.68	0.55	1.45	0.39	1.11	0.36	0.47	0.32
Div Payout	0.58	0.34	0.91	0.42	0.70	0.30	1.05	0.72

The table provides mean and median values for the companies in the sample. The variables are the logarithm of assets, revenue to assets, return on assets, debt to shareholder equity, equity to assets, earnings before tax over revenue, earnings before tax over assets, debt to assets, return on equity and dividends to earnings after tax.

Table 10: Lending to corporate customers

The table provides the results of lending to corporate customers. The table presents the results from the OLS regression and the second stage of the two stage least squares model. *Post* is an indicator of 1 in the years after deposit insurance is introduced, i.e. from 1988, 0 otherwise, and *Bank* is an indicator of 1 for all commercial banks, 0 otherwise. *Post×Bank* is the variable of interest, namely the effect of introducing deposit insurance for commercial banks relative to savings banks. T statistics are given in parentheses. The symbols ***, ** and * denote significance at the 1%, 5% and 10% level, respectively, based on robust standard errors clustered at firm level.

$$\left(\frac{D}{E}\right)_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 Bank_{it} + \beta_3 Post_{it} \times Bank_{it} + \beta_4 \ln \mathrm{TA}_{it} + \beta_5 Roa_{it} + \beta_6 \Delta TA_{it} + \beta_7 NBRate_t$$
$$+ \beta_8 Unemp_t + \beta_9 Intlong_t + \beta_{10} GDP_t + \beta_{11}\left(\frac{D}{E}\right)_{it-1} + \varepsilon_{it} \quad (1.8)$$

	Full Sample		Large institutions		Small institutions	
	OLS	IV	OLS	IV	OLS	IV
Post	-11.890	-14.250	-12.960	-15.950	8.040	8.040
	(-1.45)	(-1.39)	(-1.48)	(-1.39)	(-0.56)	(-0.56)
Bank	1.970	1.960	2.000	2.000	4.850	4.850
	(-1.15)	(-1.15)	(-1.07)	(-1.07)	(-0.71)	(-0.71)
Post×Bank	3.470	7.410	3.880	8.830	-3.280	-3.280
	(-0.64)	(-0.81)	(-0.66)	(-0.84)	(-0.53)	(-0.53)
lnTA	-0.340	-0.340	-0.430*	-0.430	3.480	3.480
	(-1.37)	(-1.37)	(-1.69)	(-1.69)	(-1.07)	(-1.07)
ROA	-2.350	-2.330	-8.270	-8.300	126.900	126.900
	(-0.3)	(-0.3)	(-1.46)	(-1.47)	(-0.92)	(-0.92)
ΔTA	10.160***	10.150***	10.150***	10.150***	5.970	5.970
	(-3.27)	(-3.27)	(-3.23)	(-3.23)	(-0.24)	(-0.24)
NBRate	4.750***	4.290***	4.680***	4.080***	4.010	4.010
	(-2.98)	(-2.93)	(-2.73)	(-2.63)	(-1.27)	(-1.27)
Unemp	2.190	1.570	2.690*	1.920*	-7.140	-7.140
	(-1.59)	(-1.38)	(-1.87)	(-1.67)	(-1.13)	(-1.13)
IntLong	-3.140**	-2.590**	-3.150**	-2.480*	-0.480	-0.480
	(-2.15)	(-2.02)	(-2.1)	(-1.91)	(-0.11)	(-0.11)
GDP	-1.170***	-1.030***	-1.280***	-1.100***	1.050	1.050
	(-2.64)	(-2.54)	(-2.82)	(-2.7)	(-0.46)	(-0.46)
D/Et-1	0.930***	0.930***	0.920***	0.920***	1.020***	1.020***
	(-28.39)	(-28.53)	(-25.74)	(-25.87)	(-28.87)	(-28.87)
Constant	-9.730	-8.040	-11.550	-9.230	-13.530	-13.530
	(-1.24)	(-1.03)	(-1.32)	(-1.06)	(-0.55)	(-0.55)

Table 11: The effect of deposit insurance on the *D-score* when savings banks that converted to commercial banks are dropped from the sample

The following model is estimated:

$$D-score_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 Bank_{it} + \beta_3 Post_{it} \times Bank_{it} + \varepsilon_{it} \quad (2)$$

The *D-score* is the predicted default value for each institution for each year obtained from Table 5. See Table 3A for variable definitions. The model is estimated using OLS with standard errors clustered at bank level. The table provides results of the effect on the *D-score*, i.e. the aggregate measure of risk estimated in Equation 2. *Post* is an indicator of 1 in the years after the introduction of deposit insurance, i.e. from 1988, 0 otherwise, and *Bank* is an indicator of 1 for all commercial banks, 0 otherwise. *Post×Bank* is the variable of interest and shows the effect of introducing deposit insurance for commercial banks relative to savings banks. T statistics are given in parentheses.

	Full sample	**Large institutions**	**Small institutions**
Constant	0.0134	0.0022	0.0146
	(2.23)	(1.62)	(2.20)
Post	0.0180	0.0047	0.0181
	(1.01)	(0.87)	(0.97)
Bank	0.0216	0.0346	0.0195
	(1.78)	(1.79)	(1.36)
PostxBank	-0.0092	-0.0065	-0.0048
	(-0.40)	(-0.44)	(-0.17)

Table 12: The effect of deposit insurance on the *D-score* when savings banks that converted to commercial banks are coded as banks for the entire period

The following model is estimated:

$$D-score_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 Bank_{it} + \beta_3 Post_{it} \times Bank_{it} + \varepsilon_{it} \quad (2)$$

The *D-score* is the predicted default value for each institution for each year obtained from Table 5. See Table 3A for variable definitions. The model is estimated using OLS with standard errors clustered at bank level. The table provides results of the effect on the *D-score*, i.e. the aggregate measure of risk estimated in Equation 2. *Post* is an indicator of 1 in the years after the introduction of deposit insurance, i.e. from 1988, 0 otherwise, and *Bank* is an indicator of 1 for all commercial banks, 0 otherwise. *Post×Bank* is the variable of interest and shows the effect of introducing deposit insurance for commercial banks relative to savings banks. T statistics are given in parentheses.

	Full sample	**Large institutions**	**Small Institutions**
Constant	0.0134	0.0022	0.0146
	(2.23)	(1.63)	(2.20)
Post	0.0180	0.0047	0.0181
	(1.01)	(0.87)	(0.97)
Bank	0.0184	0.0294	0.0172
	(1.68)	(2.02)	(1.26)
PostxBank	-0.0112	-0.0062	-0.0071
	(-0.51)	(-0.51)	(-0.27)

Table 13: First stage regression

$$Bank_{it} = \beta_0 + \beta_1 Branch_{it} + \beta_2 Growth + \beta_3 \ln TA_{it} + \beta_4 Y1989 + \beta_5 Y1990 + \varepsilon_{it}$$

Where Bank is an indicator variable with the value of 1 if the savings institution changed from savings institution to bank during the period 1988 to 1990. Branch is equal to one if the savings bank had a foreign branch in 1982 and growth is the growth rate in total assets from 1981 to 1982. The model is estimate using a Probit model from 1988 to 1990 using only data for savings banks. Y1989 and Y1990 are time dummy variables.

	Coefficient	Std.Err	T value
Branch82	0.429	(0.844)	0.51
Growth82	2.383	(4.087)	0.58
Size82	0.804***	(0.268)	3.00
Year89	11.013***	(1.358)	8.11
Year90	11.695***	(1.238)	9.45
Intercept	-24.093***	(2.536)	-9.50
McFadden R2			58.94%

Table 14: The effect of deposit insurance on the *D-score*

$$D - score_{it} = \beta_0 + \beta_1 Post_{it} + \beta_2 \widehat{Bank}_{it} + \beta_3 Post_{it} \times \widehat{Bank}_{it} + \varepsilon_{it}$$

The table provides the results of the effect on the *D-score*, i.e. the aggregate measure of risk estimated in Equation 2. The table presents the results of the second stage of the two stage least squares model. *Post* is an indicator of 1 in the years after the introduction of deposit insurance , i.e. from 1988, 0 otherwise, and *Bank* is an indicator of 1 for all commercial banks, 0 otherwise. For savings banks the indicator variable is zero until 1988 and the value obtained in Table 13 for the period 1988 to 1990. *Post×Bank* is the variable of interest, namely the effect of introducing deposit insurance for commercial banks relative to savings banks. T statistics are given in parentheses. The symbols ***, ** and * denote significance at the 1%, 5% and 10% level, respectively, based on robust standard errors clustered at bank level.

	Full sample	Large institutions	Small Institutions
	IV	IV	IV
Post	0.0151	0.0037	0.0166
	(-1.01)	(-0.62)	(-0.96)
Bank	0.021*	0.0273	0.0189
	(-1.77)	(-1.38)	(-1.31)
Post×Bank	-0.0084	-0.0044	-0.0064
	(-0.41)	(-0.29)	(-0.25)
Constant	0.0136***	0.0095**	0.0146**
	(-2.61)	(-2.06)	(-2.28)