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Bank-firm relationships and the performance of non-financial firms during the financial crisis 2008-09

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Abstract

Utilising a unique data set with annual accounts from around 37,000 Danish non-financial firms spanning one and a half decade or so, we offer microeconometric evidence on bank-firm relationships and the performance of non-financial firms during the financial crisis 2008-09. Two major conclusions are drawn from the analysis. First, the probability of default during the financial crisis 2008-09 was significantly higher for firms with a "weak" bank than for comparable firms with a "sound" bank. Second, non-defaulting firms with a "weak" bank did not have a lower return on assets during the financial crisis 2008-09 than comparable firms with a "sound" bank. Taken together, these results may indicate the presence of heterogeneous effects of having a "weak" bank with significant negative effects on the economic performance for some firms but insignificant effects for the broad mass of firms.

Key words: Financial crisis; Bank-firm relationships; Probability of default; Firm survival.
JEL Classification: E44; G21; G33.

Resumé (Danish summary)

I papiret præsenteres en mikroøkonometrisk analyse af, om den økonomiske styrke af en virksomheds bankforbindelse har haft betydning for virksomhedens økonomiske resultater under den seneste finanskrise. Datagrundlaget bag analysen er årsregnskaber aflagt af i gennemsnit omkring 37.000 virksomheder for perioden 1995-2009. Der drages to hovedkonklusioner på baggrund af analysen. For det første findes der tegn på, at virksomheder med en "svag" bankforbindelse havde en konkursrisiko i årene 2008-09, som var signifikant højere end for tilsvarende virksomheder med en "sund" bankforbindelse. For det andet findes ingen indikation af, at ikke-konkursramte virksomheders afkastningsgrad under finanskrisen har været afhængig af "sundhedstilstanden" hos virksomhedernes bankforbindelse. Samlet kunne disse resultater indikere tilstedeværelsen af heterogene effekter af at have en "svag" bankforbindelse med en signifikant negativ indvirkning på de økonomiske resultater for en mindre andel af virksomhederne, mens den økonomiske styrke af bankforbindelsen ikke har haft nogen signifikant betydning for det store flertal af virksomheder.

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1. Introduction

In the wake of the international financial crisis in 2008-09, the real effects of banking crisis have once again been among the issues at the top of the research agenda.

Switching between banks might be associated with costs due to short-term imperfect substitutability between bank credit and other sources of debt financing caused by asymmetric information problems in the relationship between debt issuers and debt holders (Bernanke, 1983). The financial health of a firm's main bank relationship might therefore be of crucial importance to the economic performance of the firm during a financial crisis. If a bank experiences financial difficulties and has to reduce its lending, the clients of the bank might have to scale down their operations and investments, cf. e.g. Gibson (1993). This can have a negative impact on the firms' economic performance such as the return on assets. In the worst case scenario financial problems in a firm's bank might increase the probability of default of the firm relative to similar firms with a "sound" bank. A firm which have a "sound" bank might better be able to overcome times of economic crisis via less restrictive access to bank credit compared to a firm with a bank in financial stress (Petersen and Rajan, 1994; Hall and Weinstein, 2000).

Utilising a unique data set on annual accounts from around 37,000 Danish non-financial firms the paper at hand offers microeconometric evidence on bank-firm relationships and the performance of non-financial firms during the financial crisis 2008-09. For each firm the data set contains information on annual accounts during the period 1995-2009 and the firm's operating status (active or exit by default, voluntarily liquidation or acquisition by another firm) during the period 1996-2010. Furthermore, for each firm a range of non-financial characteristics (age, industry, legal form, geographical location *etc*.) is also available as well as information on the firm's main Danish bank relationships since 2003. Furthermore, information on the financial health of the firms' bank prior to the recent financial crisis is available.

Based on a microeconomic analysis of this data set we draw two major conclusions. First, during the financial crisis 2008-09 the probability of default was significantly higher for firms with a "weak" bank than for firms with a "sound" bank. Second, non-defaulting firms dependent on a "weak" bank did not have a lower return on assets during the financial crisis 2008-09 than comparable firms with a "sound" bank. Taken together, these results may indicate the presence of heterogeneous effects of having a "weak" bank with significant negative effects on the economic performance for some firms but insignificant effects for the broad mass of firms.

The remainder of this paper proceeds as follows. After a brief review on the previous micro-based empirical literature on bank-firm relationships and economic performance in section 2 we offers a comprehensive description of the data and issues related to our sample selection in section 3. Our general identification strategy is explained in details in section 4 within the framework of the potential outcome approach to causality. Section 4 also contains an evaluation of the plausibility of the assumptions needed to justify our choice of econometric procedures. Section 5 explains the two measures of bank health we use in order to distinguish between "weak" and "sound" banks with particular attention to the issue of reverse causality. Our main empirical results are presented in section 6 and 7 followed by a summary of the main findings and an outline of scope for further research in section 8.

2. A short review of related literature

The paper relates mainly to the literature on bank-firm relationships. Several microeconometric studies based on firm-level and bank-level data have addressed the issue regarding financial crisis, bank-relationships and economic performance.

Gibson (1995, 1997) found that Japanese firms with low-rated bank had lower investment ratios than comparable firms with high-rated bank during the crisis in the 1990s. Using data from Japan in the 1990s and early 2000s Minamihashi (2011) also found that the clients of failed banks reduced their investments significantly.

Polonchek *et al*. (1993) found a negative share price effect on the corporate customers of the US Continental Illinois Bank after the collapse and bailout of the bank in 1984. Similar results have been found following the failure of banks in Japan in the 1990s (Murakami and Yamori, 1999; Brewer III *et al.*, 2003) and in East Asia during the crisis in the second half of the 1990s (Bae *et al*., 2002; Djankov *et al*., 2005). For Norway, Michalsen *et al*. (2003) were not able to trace similar significant share price effects of bank distress on the bank's exchange-listed clients during the systemic crisis 1988-91 and attributed mainly this finding to the firm's easy access to the equity market.

Klein *et al*. (2002) found that financial difficulties at banks had a negative impact on the number of FDI projects made by Japanese firms into the United States in the 1990s. The study was based on a data set that contained the number of FDI projects by individual Japanese firms and information on the firms' main bank relationships. Klein *et al*., *op. cit*., found that a rating downgrade of a Japanese bank by Moody's resulted in a decline of around one-third in the number of FDI projects into the United States by those firms that used the bank as their main bank. Ushijima (2008) reports similar findings.

A number of papers have focused on the link between bank health and the survival of the bank's clients. Joeveer (2004) studied a sample of 119 firms which were clients of the Land Bank of Estonia that failed in 1998 and found a higher rate of bankruptcies among the failed

bank's clients compared to a group of 114 other randomly selected Estonian firms. In a more comprehensive study Akashi *et al*. (2009) found that the financial health of a firm's bank can have a significant impact on a firm's probability of default, even after controlling for the credit-quality of the firms. The results in Akashi *et al*., *op. cit.*, were based on a multinomial probit model estimated for a sample of 6,266 unlisted Japanese companies 1997-2003 of which around 300 went bankrupt.

The paper at hand contributes to this strand of literature by providing empirical evidence on the effect of bank distress on the default risk and the return on assets of the banks' corporate customers during the recent financial crisis 2008-09 based on a comprehensive firm-level data set from Denmark. The data covers around 37,000 listed as well as unlisted non-financial firms and contains approximately 550,000 firm-year observations of annual accounts from the period 1995-2009 and a total of almost 15,000 cases of corporate defaults during the period 1996-2010. This unique micro data set is therefore considerably larger data previously analysed in the literature.

A common potential misspecification problem in empirical studies on bank-firm relationships is the issue of omitted variable biases, cf. section 4. It is therefore crucial to control for the credit-quality of the firms in order to isolate the link from the financial health of a firm's bank to the firm's probability of default or the firm's return on assets. The large data set analysed in the paper spans almost two complete business cycles and allows us to control for a large number of firm-specific variables, which are commonly known to be correlated with the credit-quality of the firm according to the accounting-based credit-scoring literature. This reduces the risk of omitted variable bias. Our paper therefore also relates to the literature on accounting-based credit-scoring models, cf. e.g. the classical survey by Altman and Saunders (1998) and the update in Alam *et al*. (2010).

3. The main data source, sample selection and data cleaning

The paper is based on a sample selected from a data set supplied by a private data vendor (Experian A/S). The database contains firm-level annual accounts from Danish limited liability companies. Experian A/S mainly collects the information from the Danish Commerce and Companies Agency but enriches the database via information from other sources, including information obtained via telephone interviews.

The total database contains annual accounts from around 73,000 firms in the period 1995-2009. This gives a total of more than 1,100,000 firm-year observations of annual accounts. For each year the data set contains information on all active Danish public and private limited liability companies.

The data set consists of a single spell for each firm. Changes in the population of firms from one year to another consist of joiners (new firms) and leavers (exits by default, voluntary

liquidation or merger). The mode of exit as well as the incorporation date of all firms is also registered in the database.

From the total database the following firms were excluded:

- All holding companies. A holding company is characterised by partial or full ownership of other companies and has typically no other activities. Danish companies owned by holding companies are, however, included in the selected sample.
- All financial firms, firms within agriculture and a range of firms owned or guarantied by the government, i.e. the analysis in this paper focuses on the non-financial and non-farm private sector.
- All companies with a balance sheet below DKK 150,000 (approximately EUR 20,000). This exclusion ensures that only active firms are included in the analysis.
- All firms without information on their main bank relationship.

After these exclusions and adjustments, the data sample contained around 550,000 firm-year observations from around 37,000 firms. Compared to the full sample we thus removed around half of the observations and the main reason was missing information on bank relationships. However, it was mostly small firms that offered no information on their bank relationships. On average for the period 1995-2009, the final sample therefore covers around 90 per cent of the total turnover and around 80 per cent of the total assets of all the firms in the original database.

In order to ensure consistency, accounting figures from firms with an accounting period shorter or longer than one year have been annualised. Companies may to some extent choose between different accounting methods, and during the period 1995-2009 some changes in accounting principles have occurred. This might result in certain data inconsistencies over time and it has not been possible to adjust the accounting figures for such inconsistencies. However, this problem is believed to be of minor importance for the analysis in this paper.

Besides accounting information the data set also contains information on a range of non-financial characteristics for each firm (age, industry, legal form, geographical location *etc*.). Furthermore, information on each firm's operating status (active or exit by default, voluntarily liquidation or acquisition by another firm) in the period 1996-2010 is available. A firm is regarded as having exited by default if one of the following situations have occurred: (a) The firm has been declared bankrupt or has entered into a bankruptcy procedure; (b) the firm has been compulsory dissolved by the court or is in a process towards compulsory dissolution; (c) the firm has experienced a write down of its debt obligations or is subject to a compulsory scheme of arrangements with the creditors; or (d) the firm has experienced a forced sale. The number of active and failed firms in the data set used for the analysis in the paper is shown in table 1.

COMPANIES INCLUDED IN THE ANALYSIS IN THIS PAPER Table 1

Year	Number of active firms, beginning of year (a)	Number of exits by		
		Failure	Voluntarily liquidation	Merger
1996	29,033	670	255	216
1997	30,013	725	257	243
1998	31,941	812	233	237
1999	34,956	839	254	294
2000	37,921	1.049	238	316
2001	40,097	1.417	318	340
2002	41,890	1.419	342	356
2003	42,675	1.322	354	526
2004	42,936	1.393	424	620
2005	39,512	944	390	444
2006	34,614	676	278	339
2007	33,028	744	257	348
2008	31,524	1.151	304	348
2009	30,273	1.207	252	274
2010	29,684	527	180	196
Average	35,340	993	289	340
Total	530,097	14,895	4,336	5,097

(a) Excluding exits during the year.
Source: Calculated by the authors based on data from Experian A/S.

Finally, a few remarks should be given regarding the registration of defaults in the data set. All defaults are attributed to the year following immediately after the last year with an account reported from a failed company. However, due to time-consuming legal proceedings *etc*. related to bankruptcy, there can be a considerable time lag between the publication of the last annual account of a failed company and until the date for the official registration of the failure. On average it takes around 19 months from the year of the last account until a failure is registered, and the 90th percentile is 34 months, cf. Lykke *et al*. (2004). Parts of the number of bankruptcies attributed to year t in the database are therefore in effect related to subsequent years.[2] However, the timing convention applied in our data analysis makes sense from an economic point of view since we are more interested in the time period where a firm has been driven by economic factors to file for bankruptcy than in the point in time where the formal bankruptcy procedures are finalised.

4. Identification strategy

To identify the causal effect of having a "weak" bank on the probability of default of a firm or the firm's return on asset during the financial crisis, we rely on the basic assumption that we are able to control for all variables that simultaneously influences the firm's choice of bank

[2] Due to this time lag the number of failed firm for 2010 stated in table 1 is only a provisional figure. However, this is not of any significance for the analysis in the paper unless the distribution on "weak" and "sound" bank for the yet to be reported failed firms differs from the distribution on "weak" and "sound" bank for the already reported failed firms.

and the outcome variables. Formally the conditional independence assumption[3] has to hold, which can be written as:

$$[1]\ Y_{weak,i}, Y_{sound,i} \perp D_i \mid X_i \ ,$$

where the stochastic variable $Y_{weak,i}$ is the potential outcome for firm i if it has a "weak" bank and $Y_{sound,i}$ is the potential outcome for firm i if it has a "sound" bank. D_i is a dummy variable for having a "weak" bank and X_i is the observed characteristics of the firm. By definition, we can only observe one of the potential outcomes and the identification strategy shows the way to estimate the counterfactual outcome. The assumption claims that conditional on X_i there is no dependence (denoted by $\perp$) between the potential outcomes and the indicator dummy for "weak" bank. It is therefore only reasonable to employ this assumption when we have access to quite detailed data on the most important variables determining the selection into different banks. Alternatively, we would have to come up with some sort of instrument that could generate the necessary exogenous variation in the choice of bank without being related to the outcome of interest. We have no information about any such instrument and have therefore found it more fruitful to include a broad range of control variables and argue that this is a reasonable strategy for attaining unbiased estimates of the effects of having a "weak" bank. We show some robustness checks for this identification strategy by also estimating effects in the years immediately prior to the financial crisis where we would not expect to find any effects related to the health of a firm's bank relationship.

Another way to think about the identification strategy applied in this paper is to apply the framework of a difference-in-differences estimator. One could first estimate the difference between firms with "weak" and "sound" banks but acknowledge that this comparison has to be adjusted for systematic differences between firms. One could therefore subsequently compare the differences between firms in different periods, i.e. in the period before and during the financial crisis. The estimators we use are not formally difference-in-differences estimators since we restrict the true difference in the years leading up to the crisis to be zero. However, this restriction is not rejected in the data.

Two potential problems regarding endogeneity of the "weak" bank indicators merit an upfront discussion. The first is the question of reversed causality, which may be a particular problem in our analysis of probability of defaults. Depending of the choice of "weak" bank indicator, default of a large firm may result in the bank becoming "weak" and not the other way around. In order to avoid this problem with reversed causality we base our "weak" bank

[3] Cf. e.g. Lechner (1999). Other strands of the literature may recognize this assumption as "selection on observable variables" (Heckman and Robb, 1985), "ignorable treatment assignment" or "unconfoundedness" (Rosenbaum and

indicators on data from just before the outbreak of the financial crisis, cf. section 5. This ensures that defaults during the financial crisis have no effect on our classification of banks into “weak” and “sound” banks.

The second potential problem is related to firms’ switching between “weak” and “sound” banks. Firms are allowed to switch between “weak” and “sound” banks without breaking our identification strategy as long as firms switch bank as a result of variables observed and used as controls in the model or unobserved variables that are unrelated to the potential outcome. If firms switch banks based on unobserved characteristics that are related to the outcome variable, then this would be problematic. This again points to the importance of making sure that we include a broad range of control variables in the model. Firms switching banks based on exogenous variation actually helps the identification strategy since this means that we can observe the potential outcome with both “weak” and “sound” bank for these firms, although not in the same year.

The general picture in the data is, that firms were switching to the “weak” banks in the period leading up to the financial crisis and then started to switch away towards “sound” banks in 2008 and 2009. However, the patterns are not dramatic and it is much more common in the data that firms have the same firm during the entire period.

5. Defining the financial health status of a bank

We use two different measures for the financial health of a firm's main bank during the financial crisis in 2008-09.

Our first measure of “weak” bank is based on the so-called "Supervisory Diamond" introduced by the Danish Financial Supervisory Authority as part of its bank supervision, cf. The Danish Financial Supervisory Authority (2010). The Supervisory Diamond for banks consists of a number of benchmarks for what must be considered as banking activity subject to enhanced risk. The benchmarks of the Supervisory Diamond concern lending growth, property exposure, large exposures, excess liquidity cover and funding ratio. We classify a bank as “weak” if it based on data from mid-2007 exceeded the limit values fixed by the Danish Financial Supervisory Authority for four out of the five benchmarks in the Diamond. Fourteen of the roughly one hundred bank relationships that the companies have reported as their main bank were classified as “weak” banks according this definition. Three of the fourteen banks were medium-sized banks whereas eleven were minor banks.

Our second measure of weak bank is based on the banks' excess capital in per cent of loan and guaranties relative to the banks’ individual capital needs according to the capital adequacy rules. We classify a bank as “weak” if it based on data from mid-2007 were among

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Rubin, 1983).

the 10 per cent of banks with the lowest excess capital ratio. Eleven of the roughly one hundred banks that the companies have reported as their main bank relationship were classified as "weak" banks according this definition. Only two of the eleven banks were identical to those banks classified as weak according to the Supervisory Diamond. This underlines the importance of using different measures of "weak" bank in order to check the robustness of the results in our analysis.

Naturally, the number of banks classified as "weak" depend on the exact limit values applied in each of the two definitions and constitutes a classic trade-off between bias and variance. We can either fix the limit values at a level that result in a low number of very "weak" banks which may result in imprecise parameter estimators due to a low number of observations of firms with a "weak" bank. Or we can use limit values that results in a broader number of banks being classified as weak banks thereby exploiting more observations with "weak" bank with the risk of diluting potential effects of having a "weak" bank.

Table 2 shows the number of firms classified as firms with respectively a "weak" and a "sound" bank relationship according to the two different measures.

NUMBER OF FIRM-OBSERVATIONS (END OF YEAR) FOR EACH DEFINITION OF "WEAK" BANK

Table 2

	"Weak" bank defined on the basis of the Supervisory Diamond in mid-2007		"Weak" bank defined on the basis of excess capital ratio in mid-2007	
	Sound bank	Weak bank	Sound bank	Weak bank
2003	42,386	2,987	44,114	1,259
2004	38,455	2,835	40,163	1,127
2005	33,368	2,539	34,898	1,009
2006	31,880	2,497	33,367	1,010
2007	30,938	2,389	32,366	961
2008	29,818	2,188	31,113	893
2009	28,679	1,908	29,814	773
Memo:				
Number of banks .	90	14	93	11

Source: See the main text.

The reason that it is important to control for systematic differences between firms with "weak" and "sound" bank relationships can be illustrated by Table 3. Firms with "weak" banks have a higher failure rate both in the period leading up to and during the financial crisis. They are also smaller measured by the amount of total assets, equity capital or the number of employees. "Weak" banks also seem to attract slightly younger firms and firms who are doing less well financially, measured by the proportion of firms with a reduction of the capital base or a critical auditor qualification, cf. the definition of these concepts in Table 4 and 8.

COMPARISON OF KEY FIGURES FOR FIRMS WITH "WEAK" AND "SOUND" BANK Table 3

	Average over 1995-2006				Average over 2007-09			
	"Weak" bank defined on the basis of the Supervisory Diamond in mid-2007		"Weak" bank defined on the basis of excess capital ratio in mid-2007		"Weak" bank defined on the basis of the Supervisory Diamond in mid-2007		"Weak" bank defined on the basis of excess capital ratio in mid-2007	
	"Sound" bank	"Weak" bank	"Sound" bank	"Weak" bank	"Sound" bank	"Weak" bank	"Sound" bank	"Weak" bank
Failure rate (per cent)	2.5	3.8	2.6	2.8	2.9	4.5	2.9	5.3
Return on assets (per cent) ..	5.6	3.8	5.4	6.2	4.8	3.6	4.7	4.8
Primary operating result (DKK million)	2.1	0.5	2.1	0.8	3.1	0.5	2.9	1.0
Total assets (DKK million)....	36.2	12.0	35.3	11.9	67.0	19.4	65.1	16.6
Equity capital (DKK million)	15.4	3.6	15.0	4.1	27.5	6.4	26.7	6.2
Debt ratio (short) (per cent of total assets)	54.0	60.2	54.4	52.9	59.8	65.4	60.1	60.1
Debt ratio (long) (per cent of total assets)	12.2	12.5	12.2	15.2	10.5	10.7	10.4	13.5
Number of employees	25.6	11.2	25.0	12.6	34.0	14.5	33.1	15.8
Age (years)	17.5	15.3	17.4	16.1	21.2	18.3	21.0	19.5
Reduction of the capital base (per cent of firms)	14.3	18.8	14.5	15.0	16.3	21.3	16.5	18.2
Critical auditor qualification (per cent of firms)	7.8	10.1	7.9	9.6	11.0	14.8	11.1	13.5
Geographical location of firms (per cent)								
Copenhagen and Frederiksberg.	13.4	28.3	14.5	5.2	12.2	28.4	13.5	4.6
The county of Copenhagen	11.6	23.1	12.5	2.8	10.5	23.0	11.7	1.7
Frederiksborg and Roskilde	12.7	24.4	13.7	2.7	11.8	23.2	12.9	3.1
Other municipalities.....	19.8	5.3	18.8	21.7	20.8	7.1	19.8	19.6
Rural district.....	42.6	18.9	40.5	67.7	44.7	18.2	42.1	71.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Classification of firms by industry (per cent)								
Trade, etc.	32.3	31.0	32.3	29.8	34.9	32.0	34.9	30.5
Construction	12.4	14.4	12.5	15.3	14.0	15.7	14.1	16.9
Letting and sale of real estate.....	23.0	25.8	23.2	21.1	20.5	25.5	20.9	19.0
Manufacturing.....	18.1	14.7	17.9	19.9	17.6	13.6	17.3	20.3
Transport, etc.....	5.3	4.2	5.2	4.9	8.9	8.5	8.9	8.0
Other	8.9	9.9	8.9	9.0	4.1	4.5	4.0	5.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number of firm-year-observations	430.843	27.662	446.627	11.878	89.435	6.485	93.293	2.627

Note: For more details on the definitions of the key figures, cf. Table 4 and 8.
Source: See the main text.

The main point to take away from Table 3 is that it is indeed important to control for systematic differences between firms but also that the groups of firms with "weak" and "sound" banks are not two completely different groups. Because of the large number of observations it seems reasonable to assume that we can construct an appropriate comparison group for the firms with a "weak" bank based on the firms with a "sound" bank. This assumption of overlapping distributions of potential outcomes across the two groups is in fact also a part of the conditional identification assumption described previously in section 4.

Simply stated, we should for each firm with a "weak" bank be able to find at least one comparable firm with a "sound" bank.

Finally, it could be noted from Table 3 that the geographical distribution of firms with a "weak" bank depends heavily on the definition of a "weak" bank. When "weak" banks are defined in accordance with the Supervisory Diamond a relatively large proportion of the corporate clients of the "weak" banks are located in Copenhagen and Frederiksberg. When "weak" banks are based on the excess capital ratio, a large proportion of the firms with "weak" banks are located in rural districts. This highlights the importance of making use of several definitions of a "weak" bank in order to access the robustness of the results.

6. The effect of bank health on firms' probability of default

Our baseline model in the analysis of firm's probability of default is a modified version of Danmarks Nationalbank's failure-rate model used in relation to the Nationalbank's assessment of the financial stability outlook, cf. Danmarks Nationalbank (2003, 2007), Lykke *et al*. (2004) and Dyrberg (2004).

The Nationalbank's failure-rate model is also estimated on the basis of the Experian A/S database described in section 3. There are, however, two main differences between our model and the failure-rate model of Danmarks Nationalbank. First, our model is only estimated on that part of the database from Experian A/S where information on the bank relationship of the firms is available. The Nationalbank's failure-rate model does not make use of this information and is therefore estimated on a larger sample. Second, our baseline model includes a richer set of dummy variables (i.e. time dummies by industry) than the Nationalbank's model in an attempt to control for differences in the credit-quality of the firm (unobserved heterogeneity) and thereby address the issue of endogeneity mentioned in section 4.

The baseline model can be seen as a competing-risks model, where a firm can exit from one year to another in one of the following three different ways: (1) the firm exits by "default"; (2) the firm exits by "voluntarily liquidation"; or (3) the firm exit via "acquisition by another firm". In case of none of these events happens the firm stays "active". Assuming that a firm's state (i.e. "active", "exit by default", "exit by voluntarily liquidation" or "exit by merger") in two subsequent years are independent of each other supplemented with an assumption of a special functional form of the state-transition probabilities given survival up until time t (hazard rates), the competing risk model can be estimated with an unordered multinomial

logit model with alternative-invariant regressors and "active firms" as the base category, cf. Allison (1982) and Dyrberg (2004).[4]

The assumption of independent exits might be seen as a strong assumption since the profitability of "exit by default" might depend on the number of years the firm already has survived. It is therefore important to control for firm age in the failure-rate model.

In the baseline failure-rate model the probability that firm j will exit by default in year t ($PD_{j,t}$) can be written as:

$$[2]\ PD_{j,t} = F\left(b_0 + \sum_{i=1}^{k} b_i X_{i,j,t-1} + \sum_{i=1}^{m} a_i Z_{i,j,t} \right),$$

where b_0 is a constant term and b_1, …, b_k, a_1, …, a_m are parameters. The explanatory variables consists of information on firm j's return on assets, debt ratio *etc*. in year t-1 ($X_{1,j,t-1}$,…, $X_{k,j,t-1}$) and a range of other firm-specific variables such as age, geographical location *etc*. in year t as well as annual time dummies by industry aimed at capturing the business cycle and trends facing the various industries ($Z_{1,j,t}$,…, $Z_{m,j,t}$). The probability of the other types of exit can be written in a parallel way, and the explanatory variables are described in details in Table 4.

[4] The econometrics of duration data and the multinomial logit model is e.g. covered by Wooldridge (2002) or Cameron et al. (2005). All econometric results presented in the paper at hand have been obtained via the use of SAS.

EXPLANATORY VARIABLES IN THE BASELINE FAILURE-RATE MODEL [2] Table 4

Explanatory variables	Expected effect on failure rate of a change in the variable	Comments
Entering with a time lag:		
Return on assets	-	The company's return on assets relative to the median return for the relevant industry. The return on assets is calculated as the company's profit before interest (primary operating result) in per cent of the total assets end of year. The expected sign (-) reflects the hypothesis that - all else being equal (including the attitude towards risks) - a high earning reduces the probability of default. Other variables (legal form of ownership and geographical location) aim at controlling for the firms' willingness to take risk.
Debt ratio (short).....	+	Short-term debt as a ratio of total assets end of year. The expected sign (+) reflects the hypothesis that a high short-term debt ratio increases the risk of default.
Debt ratio (long)	+	Long-term debt as a ratio of total assets end of year. The expected sign (+) reflects the hypothesis that a high long-term debt ratio increases the risk of default.
Size	-	Logarithm of total assets end of year deflated by the GDP-deflator (with 1995=1). The expected sign (-) reflects the hypothesis that large firms are less likely to default.
Reduction of the capital base	+	The dummy variable is set at 1 if the company has had a deficit in the most recent year and if another deficit of the same magnitude will reduce the company's equity capital to a level below the statutory capital requirement for new firms. Otherwise, it is set at 0. The expected sign (+) reflects the hypothesis is that firms with a thin capital base have a higher probability of default.
Critical auditor qualification.....	+	The dummy variable is set at 1 if the annual account have one or more critical auditor qualifications. Companies without any auditor qualifications are the reference group, for which the dummy variable is set at 0. The expected sign (+) reflects the hypothesis is that firms with critical comments from the auditors have a higher probability of default.
Entering without a time lag:		
Legal form of ownership	+	The dummy variable is set at 1 if the company is a private limited liability company in the beginning of the year. Public limited liability companies, for which the statutory capital requirement for new firms is higher, are the reference group (with the value 0).
Age	-	Dummy variables for the specific age of a firm at the beginning of the year. The reference group (with the value 0) comprises newly established companies with an age below 1 year. The expected sign (-) reflects the hypothesis that the most efficient firms tend to survive and stay in business.
Geographical location ...	-	Dummy variables ranking the companies' domiciles at the beginning of the year by municipality group, with Greater Copenhagen as the reference group (with the value 0). The Greater Copenhagen is more sensitive to cyclical fluctuations than the provinces. The expected sign (-) reflects the hypothesis that more cyclical volatility increases the risk of default.
Year dummies by industry.....	+/-	Annual time dummies by industry (7 industries) aimed at capturing the business cycle and trends facing the various industries. Manufacturing is the reference industry (with the value 0).

The baseline model is estimated via maximum likelihood and the results related to the probability of default are shown in Table 5. Due to the large number of observations a significance level of 1 per cent is practically feasible and more appropriate than the usual 5 per cent level. Employing the conventional 5 per cent significance level would increase the risk of false positive tests statistics that would lead us to see too many significant parameters. All the variables are significantly different from zero at a 1 per cent significance level and the estimated coefficients all have the expected signs, cf. also Table 4.

THE ESTIMATED BASELINE FAILURE-RATE MODEL [2] Table 5

	Coefficient estimate	Standard error	Change in the odds-ratio by a unit change in the explanatory variable
Constant term.....	-2.816***	0.0857	...
Return on assets	-0.00125***	0.000205	0.999
Debt ratio (short).....	0.359***	0.0132	1.431
Debt ratio (long).....	0.322***	0.0297	1.380
Size	-0.217***	0.00753	0.805
Critical auditor qualification	1.168***	0.0218	3.214
Legal form of ownership.....	0.354***	0.0228	1.425
Reduction of the capital base	1.281***	0.0218	3.599

Notes: The response variable is the log-odds-ratio, i.e. the probability of exit by "default" relative to the probability that the firm is "active". The figures in the column "Change in the odds-ratio by a unit change in the explanatory variable" is the antilogarithm to the corresponding coefficient estimate. Besides the variables listed in the table, the estimated model contains dummy variables for geographical location and age. Furthermore time dummies by industry are included. The model is estimated on the basis of 554,425 firm-year-observations.

* indicates that the coefficient is significant different from zero at a 10 per cent level of significance.

** indicates that the coefficient is significant different from zero at a 5 per cent level of significance.

*** indicates that the coefficient is significant different from zero at a 1 per cent level of significance.

Table 5 also shows the change in the odds-ratio by a unit change in each of the explanatory variables. The odds-ratio is the probability of exit by "default" relative to the probability that the firm is "active" (i.e. the "relative probability of default", in the following just denoted as the "probability of default"). Table 5 shows that the probability of default of a firm with a critical auditor qualification is approximately 3 times higher than the probability of default of an identical firm without a critical auditor qualification.

As a robustness test of our sample selection we also estimated the baseline failure-rate model [2] on the basis of the full sample in the original database with around 1,100,000 firm-year observations of annual accounts. The full sample includes accounts from both firms with and without information on their main bank relationship, cf. Table 6. The estimated model based on our sample consisting of firms with information on bank relationship in Table 5 comes very close to the estimated model in Table 6 based on the full sample from the original database.

THE ESTIMATED FAILURE-RATE MODEL [2] BASED ON THE FULL SAMPLE IN THE ORIGINAL DATABASE

Table 6

	Coefficient estimate	Standard error	Change in the odds-ratio by a unit change in the explanatory variable
Constant term.....	-2.181***	0.0482	...
Return on assets	-0.00158***	0.000121	0.998
Debt ratio (short).....	0.286***	0.0081	1.331
Debt ratio (long).....	0.216***	0.0173	1.241
Size	-0.273***	0.00444	0.761
Critical auditor qualification	1.063***	0.0129	2.894
Legal form of ownership.....	0.300***	0.0160	1.350
Reduction of the capital base	1.006***	0.0130	2.736

Notes: The response variable is the log-odds-ratio, i.e. the probability of exit by "default" relative to the probability that the firm is "active". The figures in the column "Change in the odds-ratio by a unit change in the explanatory variable" have been compiled as the antilogarithm to the corresponding coefficient estimate. Besides the variables listed in the table, the estimated model contains dummy variables for geographical location and age. Furthermore time dummies by industry are included. The model is estimated on the basis of 1,091,482 firm-year-observations.

* indicates that the coefficient is significant different from zero at a 10 per cent level of significance.

** indicates that the coefficient is significant different from zero at a 5 per cent level of significance.

*** indicates that the coefficient is significant different from zero at a 1 per cent level of significance.

In order to assess whether dependence on a "weak" bank during the financial crisis increased the probability of default for a firm, the baseline model [2] were expanded with a series of weak-bank-dummy variables as follows:

$$[3]\ PD_{j,t} = F\left(b_0 + \sum_{i=1}^{k} b_i X_{i,j,t-1} + \sum_{i=1}^{m} a_i Z_{i,j,t} + d_{04} D04_{j,t} + ... + d_{10} D10_{j,t} \right).$$

In [3] $D10_{j,t}$ is dummy variable which equals 1 in 2010 if firm j at the beginning of 2010 had a "weak" bank. For other years, the variable is equal to 0. The other weak-bank-dummy variables in [3] have been defined in a similar way. A positive and significant value of the parameters to the weak-bank-dummy variables during the years of the financial crisis indicate that a firm with a "weak" bank was more likely to default during the recent financial crisis than a similar firm with a "sound" bank.

To address the risk of omitted variable bias, equation [3] in addition to weak-bank-dummy variables also includes all the explanatory variables which according to the baseline failure-rate model [2] are of relevance for the failure rate of firms. As a further robustness check [3] also contains a number of additional weak-bank-dummy variables, which relate to the period prior to the financial crisis. *A priori* one should expect that the associated parameters are not significantly different from zero.

THE ESTIMATED FAILURE-RATE MODEL [3] WITH WEAK-BANK-DUMMIES Table 7

	Coefficient estimate		Standard error		Change in the odds-ratio by a unit change in the explanatory variable	
	"weak" bank defined on the basis of					
	Supervisory Diamond	Excess capital ratio	Supervisory Diamond	Excess capital ratio	Supervisory Diamond	Excess capital ratio
Constant term.....	-2.825***	-2.821 ***	0.0857	0.0857	...	...
Return on assets.....	-0.00126***	-0.00126 ***	0.000205	0.000205	0.999	0.999
Debt ratio (short).....	0.358***	0.358 ***	0.0132	0.0132	1.431	1.431
Debt ratio (long).....	0.322***	0.321 ***	0.0297	0.0297	1.379	1.379
Size	-0.217***	-0.217 ***	0.00753	0.00753	0.805	0.805
Critical auditor qualification	1.167***	1.167 ***	0.0218	0.0218	3.211	3.214
Legal form of ownership.....	0.354***	0.353 ***	0.0228	0.0228	1.424	1.424
Reduction of the capital base.....	1.280***	1.282 ***	0.0218	0.0218	3.596	3.602
D10	-0.00842	0.195	0.170	0.241	0.992	1.216
D09	0.337***	0.763 ***	0.106	0.147	1.400	2.144
D08	0.323***	0.711 ***	0.105	0.152	1.382	2.035
D07	0.302**	0.752 ***	0.128	0.174	1.352	2.122
D06	-0.121	0.268	0.160	0.233	0.886	1.307
D05	0.124	0.219	0.133	0.212	1.132	1.245
D04	0.108	0.011	0.122	0.195	1.114	1.011

Notes: The response variable is the log-odds-ratio, i.e. the probability of exit by "default" relative to the probability that the firm is "active". The figures in the column "Change in the odds-ratio by a unit change in the explanatory variable" have been compiled as the antilogarithm to the corresponding coefficient estimate. Besides the variables listed in the table, the estimated model contains dummy variables for geographical location and age. Furthermore, time dummies by industry are included. The model is estimated on the basis of 554,425 firm-year-observations.

* indicates that the coefficient is significant different from zero at a 10 per cent level of significance.

** indicates that the coefficient is significant different from zero at a 5 per cent level of significance.

*** indicates that the coefficient is significant different from zero at a 1 per cent level of significance.

Table 7 shows the results of the estimation of model [3] with the two different definitions of a "weak" bank described in section 5. Using the Supervisory Diamond to define "weak" banks the parameters d_{08} and d_{09} are clearly significant different from zero at a 1 per cent significance level. The signs of the estimated parameters are also as expected - dependence on a "weak" bank increased the probability of default of a firm during the financial crisis. The changes in the odds-ratios by a unit change in each of the explanatory variable indicate that firms with a "weak" bank had a failure rate in the years 2008-09, which was around 40 per cent higher than the failure rate of similar companies with a "sound" bank. The parameters related to the weak-bank dummies from before the financial crisis are not significantly different from zero, which are in line with the *a priori* expectations.

The results where "weak" bank are defined on the basis of the excess capital ratio gives roughly the same picture, although with a somewhat larger effect on the probability of default of having a "weak" bank. It can, however, be noted that the parameter d_{07} in this case also is clearly significant different from zero at a 1 per cent significance level. This might at first seem surprising since the financial crises only began in the second half of 2007 and was rather mild in the beginning. However, as mentioned in section 3 parts of the failures

attributed to the year 2007 in the data set actually relates to subsequent years due to the considerable time lag between the publication of the last annual account of a failed company and the date for the official registration of the failure.

A few words of caution are in order regarding the interpretation of the estimated effects on the probability of default of having a "weak" bank. First, to the extent that the explanatory variables in the failure-rate model are not sufficient to control for the credit quality of the firms the estimated effect on the probability of default of having a "weak" bank might be upward biased. This is due to the fact that "weak" banks in general have a larger share of "weak" firms in their corporate-customer portfolio, cf. section 5. The estimated effects on the probability of default of having a "weak" bank might therefore simply reflect that "weak" banks have "weak" firms as customers. Second, model [3] is based on the assumption that there is a constant effect for all firms on the probability of default of having a "weak" bank. However, the estimation results might reflect that there are significant negative effects on the economic performance for some firms but insignificant effects for the broad mass of firms. The following section therefore takes a closer look on the effect of bank health on the economic performance of non-defaulting firms during the financial crisis.

7. The effect of bank health on non-defaulting firms' return on assets

To analyse whether one can trace an effect of a "weak" bank relationship on the economic performance for non-defaulting firms during the financial crisis we took a closer look on the return on assets. Our main approach was similar to the estimation of weak-bank-effects on the probability of default. We choose to focus on the subgroup of non-defaulting firms in order to complement the analysis on defaults in the previous section. The following baseline model was estimated for the non-defaulting firms' return on assets[5]:

$$[4]\ Y_{j,t} = b_0 + \sum_{i=1}^{k} b_i X_{i,j,t-1} + \sum_{i=1}^{m} a_i Z_{i,j,t},$$

where $Y_{j,t}$ is the return on assets in year t for firm j, b_0 is a constant term and b_1, …, b_k, a_1, …, a_m are parameters. The explanatory variables consists of information on each firm's size, debt ratio *etc.* in year t-1 ($X_{1,j,t-1}$,…, $X_{k,j,t-1}$) and a range of other firm-specific variables such as export share, geographical location etc. in year t as well as annual time dummies by industry

[5] To address the issue of potential survival bias we chose not to exclude all annual accounts from failed forms. Annual accounts from a failed firm reporting its last annual account in year t are included in the data sample up to year t-1. By including all the explanatory variables (except return on assets) from our failure rate model in section 6 as explanatory variables in our model for the return on assets we make an attempt to address the issue that the development in the return on assets of failed firms might differ from the development in the return on assets of non-defaulting firms prior to year t.

aimed at capturing the business cycle and trends facing the various industries ($Z_{1,j,t}$,…, $Z_{m,j,t}$). The explanatory variables are described in Table 8.

EXPLANATORY VARIABLES IN THE BASELINE MODEL FOR RETURN ON ASSETS [4] Table 8

Explanatory variables	Comments
Entering with a time lag:	
Debt ratio (short).....	Short-term debt as a ratio of total assets end of year.
Debt ratio (long).....	Long-term debt as a ratio of total assets end of year.
Size	Logarithm of total assets end of year deflated by the GDP-deflator (with 1995=1).
Reduction of the capital base	The dummy variable is set at 1 if the company has had a deficit in the most recent year and if another deficit of the same magnitude will reduce the company's equity capital to a level below the statutory capital requirement for new firms. Otherwise, it is set at 0.
Entering without a time lag:	
Critical auditor qualification	The dummy variable is set at 1 if the annual account have one or more critical auditor qualifications. Companies without any auditor qualifications are the reference group, for which the dummy variable is set at 0.
Legal form of ownership.....	The dummy variable is set at 1 if the company end of year is a private limited liability company. Public limited liability companies, for which the statutory capital requirement for new firms is higher, are the reference group (with the value 0).
Age	Dummy variables for the specific age of a firm end of year. The reference group (with the value 0) comprises companies with an age below 1 year.
Export share.....	The share of the firm's turnover that goes to exports.
Geographical location	Dummy variables ranking the companies' domiciles end of year by municipality group, with Greater Copenhagen as the reference group (with the value 0). The Greater Copenhagen is more sensitive to cyclical fluctuations than the provinces.
Year dummies by industry	Annual time dummies by industry (7 industries) aimed at capturing the business cycle and trends facing the various industries. Manufacturing is the reference industry (with the value 0).

Model [4] includes by and large the same control variables as the baseline failure rate model [2]. Four of the explanatory variables – "debt ratio (short)", "debt ratio (long)", "size" and "reduction of the capital base" – enters into [4] with a time lag in order to avoid potential problems with endogeniety. However, it should be noted that the model for the return on assets is not a structural model in the same way as the failure rate model. The controls are mainly included in the model for the return on assets in order to account for firm-specific heterogeneity - not all the variables can be said to be key determinants in a structural model for a firm's return of assets.

THE ESTIMATED BASELINE MODEL [4] FOR THE RETURN ON ASSETS		Table 9
	Coefficient estimate	Standard error
Constant term	2.792***	0.484
Critical auditor qualification	-4.870***	0.137
Legal form of ownership	0.582***	0.085
Export share	0.018***	0.002
Size (lagged)	-0.239***	0.029
Debt ratio (short) (lagged)	0.051***	0.001
Debt ratio (long) (lagged)	0.033***	0.002
Reduction of the capital base (lagged)	-13.194***	0.123

Notes: The response variable is the return on assets calculated as the company's profit before interest (primary operating result) in per cent of the total assets end of year. Besides the variables listed in the table, the estimated model contains dummy variables for geographical location and age. Furthermore time dummies by industry are included. The model is estimated on the basis of 463,158 firm-year-observations. Compared to the failure-rate model estimated in the previous section, we loose 82.280 observations due to the inclusion of lagged variables and an additional 8.987 observations because we focus on the subgroup of non-defaulting firms.

* indicates that the coefficient is significant different from zero at a 10 per cent level of significance.

** indicates that the coefficient is significant different from zero at a 5 per cent level of significance.

*** indicates that the coefficient is significant different from zero at a 1 per cent level of significance.

Since the firm-specific heterogeneity is assumed to be captured by the large number of explanatory variables the model can be estimated via pooled OLS. The results are shown in Table 9. The model indicates e.g. that a firm with a critical auditor qualification has a return on assets, which all else equals is five percentage points lower than the return on assets for an identical firm without a critical auditor qualification.

As the second step the baseline model [4] were expanded with a series of weak-bank-dummy variables as follows:

$$[5]\ Y_{j,t} = b_0 + \sum_{i=1}^{k} b_i X_{i,j,t-1} + \sum_{i=1}^{m} a_i Z_{i,j,t} + d_{05} D05_{j,t} + \ldots + d_{09} D09_{j,t}.$$

In [5] $D09_{j,t}$ is dummy variable which equals 1 in 2009 if firm j at the end of 2009 had a "weak" bank . For other years, the variable is equal to 0. The other weak-bank-dummy variables in [5] have been defined in a similar way. A negative and significant value of the parameters to the weak-bank-dummy variables during the years of the financial crisis indicate that a firm with a "weak" bank had a lower return on assets during the recent financial crisis than a similar firm with a "sound" bank.

As a robustness check model [5] also contains a number of additional weak-bank-dummy variables, which relate to the period prior to the financial crisis. *A priori* one should expect that the associated parameters are not significantly different from zero.

THE ESTIMATED BASELINE MODEL [5] FOR THE RETURN ON ASSETS WITH WEAK-BANK-DUMMIES Table 10

	"weak" bank defined on the basis of			
	Supervisory Diamond		Excess capital adequacy ratio	
	Coefficient estimate	Standard error	Coefficient estimate	Standard error
Constant term	2.811***	0.484	2.791***	0.484
Critical auditor qualification	-4.869***	0.137	-4.869***	0.137
Legal form of ownership	0.583***	0.085	0.583***	0.085
Export share	0.018***	0.002	0.018***	0.002
Size (lagged)	-0.239***	0.029	-0.239***	0.029
Debt ratio (short) (lagged)	0.051***	0.001	0.051***	0.001
Debt ratio (long) (lagged)	0.033***	0.002	0.033***	0.002
Reduction of the capital base (lagged)	-13.194***	0.123	-13.194***	0.123
D09	0.286	0.602	-0.328	0.937
D08	-0.929	0.572	-0.679	0.887
D07	-0.440	0.552	1.474*	0.858
D06	-0.901*	0.539	-0.883	0.838
D05	-0.455	0.532	-0.071	0.824

Notes: The response variable is the return on assets calculated as the company's profit before interest (primary operating result) in per cent of the total assets end of year. Besides the variables listed in the table, the estimated model contains dummy variables for geographical location and age. Furthermore time dummies by industry are included. The model is estimated on the basis of 463,158 firm-year-observations.
* indicates that the coefficient is significant different from zero at a 10 per cent level of significance.
** indicates that the coefficient is significant different from zero at a 5 per cent level of significance.
*** indicates that the coefficient is significant different from zero at a 1 per cent level of significance.

Table 10 shows the results of the estimation of model [5] with the two different definitions of a "weak" bank described in section 5. There are no indications that non-defaulting firms dependent on a "weak" bank had a lower return on assets during the financial crisis 2008-09 than comparable firms with a "sound" bank. This result might reflect that non-defaulting firms with "weak" bank were not affected by a tightening of the bank's credit standards during the financial crisis. It could also reflect that the non-defaulting firms were able to obtain the necessary funding elsewhere to the extent that their "weak" bank could not accommodate their funding needs. However, it might also reflect, that a "weak" bank only has a negative effect on the return on assets for non-defaulting firm in the longer run.

8. Finalising remarks and scope for further research

Utilising a unique data set with annual accounts from around 37,000 Danish non-financial firms spanning one and a half decade or so, we have offered new microeconometric evidence on the effect of bank's financial health on their corporate customer's economic performance during the recent financial crisis.

We studied the effect of bank health both on the firms' probability of survival as well as on the return on assets of non-defaulting firms. Two major conclusions were drawn from the analysis.

First, the probability of default during the financial crisis 2008-09 was significantly higher for firms with a "weak" bank than for comparable firms with a "sound" bank. Second, non-

defaulting firms dependent on a “weak” bank did not have a lower return on assets during the financial crisis 2008-09 than comparable firms with a “sound” bank.

Taken together, these results may indicate the presence of heterogeneous effects of having a "weak" bank with significant negative effects on the economic performance for some firms but insignificant effects for the broad mass of firms. Suppose for instance, that instead of a constant effect for all firms, some firms experience a relatively large effect whereas others experience no effect at all. The large effect for some firms may result in a significant increase in the number of bankruptcies without affecting the average return on assets in a similar way since the majority of firms experience no effect. This could explain why a model focused on the default probability picks up an effect whereas no effect is found on the return on assets for non-defaulting firms. A deeper analysis of this issue is outside the scope of the paper at hand but could be an interesting topic for future research.

In the paper we have focused our robustness checks on sample selection issues and alternative measures of bank health. The focus has in other words been on the identification strategy and data quality but some additional robustness checks for the econometric estimation techniques may also be relevant. The econometric approach applied in the analysis of the firms’ probability of default has been based on a multinomial logit model in order to facilitate comparisons to the Nationalbank’s failure-rate model used in relation to the Nationalbank’s assessment of financial stability. Further robustness checks of the results from our failure-rate analysis could be carried out within the framework of a multinomial probit model. The econometric approach chosen in the analysis of non-defaulting firms’ return on assets relied on pooled OLS with a rich set of explanatory variables on order to control for firm-specific heterogeneity. The robustness of these results could be further assessed using panel data models with fixed effects. This would relax the dependence on detailed control variables but would potentially run into identifications problems since most firms have the same main bank relationship during the entire period. Time-invariant variables are not allowed in fixed effects models and the identification the parameters to the bank relationship variable would therefore rest entirely on firms switching between banks during the period.

Finally, it should be mentioned that the analysis in the paper has focused on the effect of bank relationships on the performance of non-financial firms during the financial crisis 2008-09. However, since the data set span almost two complete business cycles it could also serve as the basis for future studies on the relationship between bank health and economic performance during times without systemic pressure on the banking system. This might for instance offer new empirical evidence on the role of the credit channel in the monetary transmission process.

9. References

Akashi, Kentaro, Shin-ichi Fukuda and Munehisa Kasuya (2009), Impaired bank health and default risk, *Pacific-Basin Finance Journal*, Vol. 17, pp. 145–162.

Alam, Md. Moudud, Kenneth Carling and Chengcheng Hao (2010), Review of the literature on credit risk modeling : development of the past 10 years, *Banks and Bank Systems*, Vol. 5(3), pp. 43-60.

Allison, Paul D. (1982), Discrete-Time Methods for the Analysis of Event Histories, *Sociological Methodology*, Vol. 13, pp. 61-98.

Altman, Edward I. and Anthony Saunders (1998), Credit risk measurement: Developments over the last 20 years, *Journal of Banking & Finance*, Vol. 21(1), pp. 1721-1742.

Bae, Kee-Hong, Jun-Koo Kangc and Chan-Woo Lim (2002), The value of durable bank relationships: evidence from Korean banking shocks, *Journal of Financial Economics*, Vol. 64, pp. 181–214.

Bernanke, Ben S. (1983), Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression, *American Economic Review*, Vol. 73(3), pp. 257-276.

Brewer III, Elijah, Hesna Genay, William Curt Hunter and George G. Kaufman (2003), The value of banking relationships during a financial crisis: Evidence from failures of Japanese banks, *Journal of the Japanese and International Economies*, Vol. 17, pp. 233–262.

Cameron, A. Colin and Pravin K. Trivedi (2005), *Microeconometrics*, Cambridge: Cambridge University Press.

The Danish Financial Supervisory Authority (2010), *Finanstilsynet introducerer 'Tilsynsdiamanten' for pengeinstitutter* (The Danish Financial Supervisory Authority introduces the Supervisory Diamond for banks – in Danish only), 25 June.

Danmarks Nationalbank (2003), Model for quantification of probable failure rates by sector, *Financial stability*, pp. 44-48,

Danmarks Nationalbank (2007), Danmarks Nationalbank's Failure-Rate Model, KIM, *Financial stability*, pp. 107-112,

Djankov, Simeon, Jan Jindra and Leora F. Klapper (2005), Corporate valuation and the resolution of bank insolvency in East Asia, *Journal of Banking & Finance*, Vol. 29, pp. 2095–2118.

Dyrberg, Anne (2004), Firms in Financial Distress: An Exploratory Analysis, *Danmarks Nationalbank Working Paper*, No. 17, June.

Gibson, Michael S. (1993), Long-term banking relationships in general equilibrium, *Board of Governors of the Federal Reserve System International Finance Discussion Paper*, No. 452, September.

Gibson, Michael S. (1995), Can Bank Health Affect Investment? Evidence from Japan, *Journal of Business*, Vol. 68(3), pp. 281-308.

Gibson, Michael S. (1997), More Evidence on the Link between Bank Health and Investment in Japan, *Journal of the Japanese And International Economies*, Vol. 11, pp. 296–310.

Hall, Brian J. and David E. Weinstein (2000), *Main Banks, Creditor Concentration, and the Resolution of Financial Distress in Japan*, in: Masahiko Aoki and Gary R. Saxonhouse (eds.), *Finance, governance, and competitiveness in Japan*, New York: Oxford University Press, pp. 64-80.

Heckman, James J. and Richard Robb Jr. (1985), Alternative Methods for Evaluating the Impact of Interventions: An overview, *Journal of Econometrics*, Vol. 30(1-2), pp. 239-267.

Joeveer, Karin (2004), Does bank failure affect client firms? Micro evidence from Estonia, *CERGE-EI Working Paper*, No. 224, May.

Klein, Michael W., Joe Peek and Eric S. Rosengren (2002), Troubled Banks, Impaired Foreign Direct Investment: The Role of Relative Access to Credit, *American Economic Review*, Vol. 92(3), pp. 664-682.

Lechner, Michael (1999), Earnings and Employment Effects of Continuous Off-the-Job Training in East Germany after Unification, *Journal of Business & Economic Statistics*, Vol. 17(1), pp. 74-90.

Lykke, Morten, Kenneth Juhl Pedersen og Heidi Mølgaard Vinther (2004), A Failure-Rate Model for the Danish Corporate Sector, *Danmarks Nationalbank Working Paper*, No. 16, May.

Michalsen, Dag, Steven Ongena and David C. Smith (2003), Firms and their distressed banks: lessons from the Norwegian banking crisis, *Journal of Financial Economics*, Vol. 67(1), pp. 81–112.

Minamihashi, Naoaki (2011), Credit Crunch Caused by Bank Failures and Self-Selection Behavior in Lending Markets, *Journal of Money, Credit and Banking*, Vol. 43(1), pp. 133-161.

Murakami, Akinobu and Nobuyoshi Yamori (1999), Does bank relationship have an economic value? The effect of main bank failure on client firms, Economics Letters, Vol. 65, pp. 115–120.

Petersen, Mitchell A. and Raghuram G. Rajan (1994), The Benefits of Lending Relationships: Evidence from Small Business Data, *Journal of Finance*, Vol. 49(1), pp. 3-37.

Polonchek, John A., Myron B. Slovin and Marie E. Sushka (1993), The Value of Bank Durability: borrowers as Bank Stakeholders, *Journal of Finance*, Vol. 48(1), pp. 247–266.

Rosenbaum, P. and D. Rubin (1983), The Central Role of the Propensity Score in Observational Studies for Causal Effects, *Biometrika*, Vol. 70(1), pp. 41-55.

Ushijima, Tatsuo (2008), Domestic bank health and foreign direct investment, *Journal of the Japanese and International Economies*, Vol. 22(3), pp. 291–309.

Wooldridge, Jeffrey M. (2002), *Econometric Analysis of Cross Section and Panel Data*, Cambridge Mass.: MIT Press.