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Real effects of credit supply shocks: evidence from Danish banks, firms, and workers

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Abstract

Contractions in credit supply can lead firms to reduce their level of employment, yet little is known about how these shocks affect the composition of firms' employees and outcomes at the worker level. This paper investigates how bank distress affects credit provision and its effects on employment beyond firm-level aggregates. To do so, we use a novel dataset built from administrative and tax records linking all banks, firms, and workers in Denmark. We show that banks that were particularly exposed to the 2008-09 financial crisis cut lending to firms, and firms were unable to fully compensate with financing from alternate sources. The decrease in credit supply led to a drop in firm-level employment, with effects concentrated among firms with low pre-crisis liquidity, and on employment of low-educated and non-managerial workers. At the worker level, we find that positive effects on unemployment were driven by effects on low-educated, non-managerial and short-tenured workers. Our estimates suggest that cuts in bank lending can account for at least 5% of the fall in employment of low-educated workers in our sample, and are an important factor behind heterogeneous employment dynamics in times of contractionary credit.

JEL classification: E24, E44, G01, G21, J23

Keywords: Bank lending, Firm borrowing, Labour demand, Financial crisis

Non-technical summary

There is growing evidence that pressures within the banking system can lead to contractions in banks' credit-supply, and that these can have real macroeconomic effects, including on employment. But do these shocks to credit supply impact the composition of employment, or outcomes at the worker level? And if so, how? Answers to these questions are important in understanding the impacts of frictions in credit and labour markets. They also provide a deeper understanding of different employment dynamics for various types of workers over the business cycle, and their impacts at the worker level.

In this paper, we study the transmission of shocks to banks' liquidity on the provision of credit to firms, and estimate the resulting effects on real outcomes for firms and workers. Our approach exploits a novel bank-firm-worker linked dataset built from Danish administrative and tax records between 2004 and 2011. Specifically, we identify banks that were particularly exposed to the 2008-09 financial crisis and compare the evolution of outcomes of the firms they lent to — and those firms' employees — to outcomes of firms and their employees borrowing from less exposed banks.

In line with previous studies, we find that firms primarily connected to exposed banks before the crisis reduced employment relative to firms connected to non-exposed banks. Our findings suggest that the reduction in credit supply can explain roughly 5% of the overall reduction in employment from 2007 to 2008 in Denmark. The effect of pre-crisis primary bank exposure on employment was greatest for firms with low pre-crisis liquidity, and concentrated on employment in non-managerial positions and among low-educated workers. For workers, the impact of reductions in firms' access to credit varied with worker characteristics. We find that effects on unemployment were driven by non-managerial, low-educated, and short-tenured workers. These findings show that affected workers were not fully able to obtain employment in other firms.

Identifying shocks to credit supply and their subsequent effects is challenging as it requires separating changes in credit supply from changes in credit demand. Our approach is as follows. First, for each firm, in each year, we identify a primary bank based on the firm's relative loan and deposit balances. In the run-up to the financial crisis, some of these banks departed from a largely deposit-based model of loan financing, relying to an increasing degree on funding acquired on international inter-bank markets. When these markets suddenly froze in the autumn

of 2008, banks with larger deposit deficits experienced severe liquidity shortfalls. We harness this variation to define the banks in our sample as more or less exposed to the financial crisis based on their pre-crisis loans-to-deposits ratio.

We then provide evidence that bank distress permeated to the real economy through two subsequent steps in a causal chain. The first of these is the 'bank-lending channel', by which exposed banks reduced their supply of credit to firms relative to non-exposed banks. We document that lending from exposed banks decreased more than lending from non-exposed banks during the crisis. However, these patterns could also be the result of a contemporaneous drop in credit demand. To look at credit supply in isolation, we study the sub-sample of firms that borrowed from both exposed and non-exposed banks, and find a persistent reduction in loan balances at exposed banks between 2008 and 2011. Comparing lending from banks with different exposure for the same firm in the same year captures credit demand effects and completely, hence, the relative drop in loan balances must reflect a drop in credit supply.

Next, we document the 'firm-borrowing channel', by which firms were unable to fully compensate for the drop in lending from exposed banks with credit from alternate sources. To do so, we turn to our main differences-in-differences identification, comparing outcomes of firms with pre-crisis primary banks that were either exposed or non-exposed. Exposure of a firm's primary bank was associated with a significant decrease in borrowing from that bank, along with a smaller increase in borrowing from other banks. The results imply a net decrease in total bank borrowing. At the same time, firms with an exposed primary bank saw an increase in the interest rate paid on their loans. Together, these findings provide further evidence of a shift in credit supply.

Taken together, our findings shed light on the interaction of frictions in credit and labour markets and highlight the role that credit plays in explaining employment dynamics. Due to frictions in credit markets, firms are unable to fully offset reductions in borrowing from some creditors with additional financing from others. Frictions in labour markets also hinder workers affected by reduced credit supply from finding new employment without experiencing periods of unemployment. Our findings document these consequences and highlight the importance of policies such as capital requirements for banks or targeted labour market policies aimed at preventing bank distress and cushioning the impacts of the real effects of credit supply shocks.

1 Introduction

There is growing evidence that pressures within the banking system can spread to the real economy via contractions in banks' credit-supply. Recent studies have documented that a drop in credit supply during the 2008-09 financial crisis had significant impacts on firm-level outcomes, including employment (Bentolila et al., 2018; Berton et al., 2018; Chodorow-Reich, 2014; Huber, 2018; Popov and Rocholl, 2018) and investment (Campello et al., 2010; Cingano et al., 2016; Duchin et al., 2010). Yet little is known about effects on the composition of employment and outcomes at the worker level. Do shocks to credit supply lead firms to simply downscale or to fundamentally adjust the labour inputs used in their production? Do workers suffer consequences on the labour market as a result? If so, which ones?

Answers to these questions are important in understanding the impacts of frictions in credit and labour markets. They also provide a deeper understanding of heterogeneous employment dynamics for different types of labour over the business cycle (Hershbein and Kahn, 2018; Jaimovich and Siu, 2020), and their impacts on workers (Hoynes et al., 2012). Pursuing these answers is challenging, however, as it requires distinguishing between changes in credit supply and credit demand, while also requiring detailed data at the bank, firm, and worker levels. In this paper, we study the transmission of shocks to banks' liquidity on the provision of credit, and estimate the resulting effects on real outcomes for firms and workers. Our approach exploits a novel bank-firm-worker linked dataset built from Danish administrative and tax records between 2004 and 2011. Specifically, we identify banks that were particularly exposed to the 2008-09 financial crisis and compare the evolution of outcomes of the firms they lent to — and those firms' employees — to outcomes of firms and their employees borrowing from less exposed banks.

We find evidence of a reduction in credit supply and related effects on both firms and workers. Beginning in 2008, firms shifted their borrowing away from exposed banks. Firms primarily connected to more exposed banks were unable to fully offset the drop in lending by borrowing from alternate sources as their bank debt and total debt fell. The decline in borrowing was accompanied by a reduction in firm-level employment. The effects were concentrated among firms with low pre-crisis liquidity, and on employment of low-educated workers and non-managers. Workers employed on the verge of the crisis at firms that faced a reduction in credit supply experienced an increase in the probability of unemployment. These effects were largest among

low-educated workers, non-managers, and short-tenured workers.

Our approach to identifying a shift in credit supply, and estimating its effects, closely follows that of Jensen and Johannesen (2017).[1] For each firm, in each year, we identify a primary bank based on the firm's loan and deposit balances. In the run-up to the financial crisis, some of these banks departed from a largely deposit-based model of loan financing, relying to an increasing degree on funding acquired on foreign inter-bank markets. When these markets suddenly froze in the autumn of 2008, banks with larger deposit deficits experienced severe liquidity shortfalls. We harness this variation to define the banks in our sample as more or less exposed to the financial crisis based on their pre-crisis loans to deposits ratio.[2]

We then provide evidence that bank distress permeated to the real economy through two subsequent steps in a causal chain. The first of these is the 'bank-lending channel', where exposed banks reduced their supply of credit to firms relative to non-exposed banks. We document that lending from exposed banks decreased more than lending from non-exposed banks during the crisis. While consistent with a drop in credit supply, differences in lending patterns could of course also be due to a contemporaneous drop in credit demand from firms borrowing from exposed banks. To control for demand, we then study the sub-sample of firms that borrowed from both exposed and non-exposed banks, and find a persistent reduction in loan balances at exposed banks between 2008 and 2011. Comparing the growth in loan balances from banks with different exposure for the same firm in the same year completely absorbs firm-specific credit demand. Any systematic fall in loan balances at exposed banks must then be due to a drop in credit supply.[3]

Next, we document the 'firm-borrowing channel', meaning that firms were unable to fully compensate for the drop in lending from exposed banks with credit from alternate sources. To do so, we turn to our main differences-in-differences identification strategy, comparing outcomes

[1] Jensen and Johannesen (2017) exploit a companion dataset at the household level, estimating the effects of a reduction in credit supply during the financial crisis on household consumption in Denmark. They document a relative drop in bank debt and total debt of a similar magnitude for households as we do for firms, and find significant negative effects of the shock to household credit supply on consumption.

[2] To be exact, we look at each bank's outstanding loans to deposits ratio in 2007. Other empirical studies employ a number of proxies for banks' exposure to the financial crisis including being a recipient of government bailouts (Bentolila et al., 2018), loss announcements (Popov and Rocholl, 2018), and reliance on the inter-bank market (Cingano et al., 2016; Iyer et al., 2014). Chodorow-Reich (2014) considers exposure to Lehman Brothers, exposure to mortgage-backed securities, trading account losses, real-estate write-offs, as well as banks' deposits to assets ratio.

[3] This is an application of the within estimator introduced by Khwaja and Mian (2008).

of firms with exposed pre-crisis primary banks to those of firms with non-exposed pre-crisis primary banks. Exposure of a firm's pre-crisis primary bank was associated with a significant decrease in borrowing from the primary bank, along with a small increase in borrowing from other banks. This resulted in a net decrease of roughly 6% in total bank borrowing betweeen 2008 and 2010. At the same time, firms with an exposed pre-crisis primary bank saw a 0.2 percentage point increase in the effective interest rate paid on their loans. Together, the decrease in the quantity of credit and the increase in its price provide further evidence of a shift in supply. Total debt for firms with an exposed pre-crisis primary bank fell by roughly 2% suggesting that these firms were unable to fully offset the reduction in bank lending with nonbank credit. This includes debt from suppliers, which decreased by 3%, suggesting that bank debt and trade credit may be compliments (Burkart and Ellingsen, 2004).[4]

A key premise of the firm-borrowing channel is that firm-bank relationships are sticky. Otherwise, the exposure of firms' pre-crisis banks would matter little if firms could costlessly and easily form new banking relationships. Sticky relationships have been shown to be a feature of credit markets with frictions for a number of reasons, including asymmetric information on the creditworthiness of new clients (Sharpe, 1990), switching costs (Klemperer, 1987), or bank-market specialisation (Paravisini et al., 2017).

In our first set of main results, we show that the reduction in credit supply had an impact on firm-level employment. Between 2008 and 2010, employment at firms with an exposed pre-crisis primary bank fell by nearly 2% relative to firms with a non-exposed pre-crisis primary bank. Over half, but not all of the effect on employment can be attributed to firm exit.[5] Effects on employment for firms with low pre-crisis liquidity were nearly ten times as large in magnitude as for firms with high liquidity. These results are consistent with models in which firms use liquid assets to protect their physical and employee search capital (Boeri et al., 2018) or to pay wages (Melcangi, 2017). We also find that the drop in credit supply had an effect on the

[4]There is a large body of literature that documents the heavier reliance on trade credit of financially constrained firms, including contributions by Casey and O'Toole (2014), Garcia-Appendini and Montoriol-Garriga (2013), Petersen and Rajan (1997), and Wilner (2000). Burkart and Ellingsen (2004) develop a model of trade credit provision in which trade credit and bank debt can be compliments for financially constrained firms. Crucially, trade credit is less liquid than bank financing and cannot be as easily diverted (used in ways that do not maximize the borrower's return, such as paying wages).

[5]The evidence in the literature on the importance of the extensive margin is mixed. Bentolila et al. (2018) find that the majority of job losses due to the drop in credit supply were driven by firm exits in Spain, while Berton et al. (2018) find that firm exit played a smaller role in Italy.

composition of firms' labour inputs. We find that effects on employment were concentrated almost entirely on employment of low-educated workers. These findings suggest that access to credit may be an important factor in explaining the large aggregate decrease in employment of low-educated workers during the financial crisis in Denmark. Back-of-the-envelope calculations suggest that the reduction in credit supply can explain at least 4% of the overall reduction in employment from 2007-2008 in our sample, or at least 5% of the fall in employment of low-educated workers. Further, we find that the aggregate effect on employment was overwhelmingly driven by a negative impact on employment in non-managerial positions. These findings are broadly consistent with those of Sforza (2019) suggesting a decrease in managers' span of control.

At the firm level, we also study the effect of the reduction in credit supply on the tenure profile of firms' employees. Our estimates suggest a negligible effect on average years of employee tenure, yet these results may mask heterogeneous effects along the tenure distribution. More generally, employment effects of a shock to credit supply at the firm level do not necessarily translate into effects at the worker level. Small or no changes in the stock of a firm's employees may hide larger flows in and out of its workforce.

Our results on employment at the firm level suggest that firms responded to credit supply shocks by shedding jobs. However, it could also be the case that workers themselves responded to the shock to their firm's credit supply by seeking employment elsewhere. To distinguish between these alternatives, we explore how the credit supply shock affected workers' probability of being unemployed as an indicator of involuntary separations. Our empirical approach at the worker level mirrors that at the firm-level, comparing outcomes of workers employed pre-crisis at firms with an exposed pre-crisis primary bank to those of workers employed pre-crisis at firms with a non-exposed pre-crisis primary bank. We find a modest increasing effect of the reduction in firm credit supply on the probability of worker unemployment, yet effects vary substantially with employee characteristics. Low-educated workers and non-managers experienced a significant, positive impact on the probability of unemployment, while high-educated workers and managers experienced minimal unemployment effects from the shock to credit supply. Together with our findings at the firm level, these results suggest that workers in groups most affected by the cut in employment were not spared from periods of unemployment. Along the tenure dimension, our results show a significant and persistent positive impact on unemployment for short-tenured workers, as well as a positive but temporary effect on unemployment for longer-tenured workers.

These results may reflect differences in firing costs (Cavalcanti, 2004), wages (and therefore immediate costs to the firm; Mincer and Jovanovich, 1979), or productivity (Shaw and Lazear, 2008). Together, our results at the worker level provide further evidence that firms facing a credit shock did indeed shed employment.

A primary concern with our research design is that shocks to firms' credit supply may correlate with their credit demand. This may be the case if firms borrowing primarily from exposed banks experienced a drop in credit demand concurring with the drop in credit supply. Systematic sorting of 'bad' (less liquid, more bank-dependent) firms to 'bad' (riskier, less capitalised, more wholesale-funded) banks may lead our approach to pick up an effect driven by a mix of supply and demand factors.[6] We address this concern in a number of ways. First, we show that over a broad range of characteristics, the average firm with an exposed pre-crisis primary bank is remarkably similar to the average firm with a non-exposed pre-crisis primary bank. Second, in our main empirical approach we include firm fixed effects and control for a number of pre-crisis covariates interacted with time dummies to account for factors such as region- and industry-level demand shocks.

This paper relates to several literatures. Starting with Bernanke (1983), a large literature studies the real effects of disruptions in credit markets.[7] The events of the Great Recession brought renewed interest with a number of empirical studies identifying bank lending drops and estimating their effects at the firm level.[8] The literature has paid little attention, however, to effects within the firm and at the worker level. Exceptions include Bentolila et al. (2018), Berton et al. (2018), and Popov and Rocholl (2018), who study firms' use of permanent vs. fixed-term contracts, Sforza (2019), who studies responses in firms' organizational hierarchies, Moser et al. (2020), who study effects on workers at different paygrades, and Hochfellner et al. (2015), who study effects on individuals' employment status and earnings.[9] We contribute to this literature

[6] In the US context, Schwert (2018) finds evidence to the contrary: more bank-dependent firms tend to match with better capitalised banks. This matching serves to improve access to more bank-dependent firms during crises and dampens the transmission of credit shocks through the bank-lending channel.

[7] Peek and Rosengren (1997) offer early empirical evidence of the bank-lending channel, while Peek and Rosengren (2000) study effects on construction activity in US commercial real estate markets.

[8] See Alfaro et al. (2019), Bentolila et al. (2018), Campello et al. (2010), Chodorow-Reich (2014), Cingano et al. (2016), Cortes et al. (2019), Duchin et al. (2010), Huber (2018), and Popov and Rocholl (2018)

[9] Compared to this paper, these studies differ in important ways. Berton et al. (2018) only have data from a single region in Italy and only focus on effects at the firm level. Hochfellner et al. (2015) rely on shocks to credit supply at the regional level rather than through direct firm-bank linkages. Bentolila et al. (2018), Popov and Rocholl (2018), and Sforza (2019) only focus on effects at the firm level. Importantly, none of these papers consider differential effects along the tenure dimension.

by showing that the reduction in credit supply led firms to not only decrease employment but also change its composition, specifically by reducing the employment of low-educated workers and non-managers. Further, we show that the effects extended to workers and document which types of workers were most affected.

More generally, our paper relates to the literature on firm behaviour in the face of credit constraints. When capital markets are perfect and complete, as in Modigliani and Miller (1958), financial constraints have no bearing on firms' decisions. In contrast, Greenwald and Stiglitz (1990) propose a theoretical framework in which information asymmetries in financial markets can lead to financial constraints, affecting investment and productivity. A large body of literature has attempted to empirically estimate these effects, as well as the impact of financial constraints on firm innovation (Hall, 2002), exporting decisions (Greenaway et al., 2007), and even corporate philanthropy (Hong et al., 2012).[10] In a paper closely related to ours, Caggese, Cuñat, and Metzger (2019) study the effect of financial constraints on firms' firing decisions across worker tenure. Their results suggest that financial constraints lead firms to sub-optimally let go of lower-tenured workers, who have higher expected productivity growth. Our findings are broadly consistent with theirs, and in addition, suggest that short-tenured workers also experience persistent increases in unemployment following job separation.

Finally, our paper relates broadly to the literature studying the heterogeneous impacts of recessions across different types of workers. Hoynes (1999) and Hoynes et al. (2012) show that less educated, non-white, and female workers are more vulnerable in terms of employment and earnings over the business cycle in the US. In the context of the 2008-09 financial crisis, Hershbein and Kahn (2018) show that worsening economic conditions led firms to restructure production in favor of higher-skilled workers. We contribute to this literature by documenting that the fall in aggregate employment during the Great Recession in Denmark occurred largely among low-educated, non-managerial workers, and highlight access to credit as a contributing factor. Further, we show that workers in these groups suffered real consequences in terms of unemployment.

The remainder of this paper is structured as follows. Section 2 provides some background information on the Danish labour and credit markets, and the financial crisis in Denmark.

[10] See Stein (2003) for a survey of the empirical literature on firm investment under financial constraints more generally.

Section 3 describes the data and sample restrictions, and presents descriptive statistics. In Section 4 we provide evidence of the shock to firms' credit supply. Section 5 presents and discusses the results on the effects of the credit supply shock on outcomes at the firm and worker levels. Section 6 concludes.

2 Background

The Danish banking sector features a few large banks and many small and medium-sized banks. Together, the four largest commercial banks account for upwards of 80 % of total lending. Bank debt is often the primary source of funding for non-financial firms in Denmark, particularly small and medium-sized firms. This is in part a consequence of the Danish tax system, which incentivises debt financing over equity (Abildgren et al., 2014).

Besides banks, the Danish financial system also includes mortgage-lending institutions (*realkreditinstitutter*). These institutions are funded entirely by publicly traded bonds, are more regulated than retail banks, and lend exclusively to commercial and private borrowers in financing real estate purchases. As credit from mortgage-lending institutions is secured by the value of an underlying property, it is typically offered on more favourable terms than credit from commercial banks. Mortgage-lending institutions are therefore often the lenders of long-term debt, while commercial banks provide marginal, short-term credit typically used to cover operating expenses (Andersen, 2017).

The Danish labour market is characterised by a unique combination of flexibility and worker mobility, with a comprehensive social security net. A pillar of the Danish 'flexicurity' model is the relatively lenient employment protection legislation, which is reflected in high levels of job turnover (Andersen, 2017). Pay, working hours and terms of employment are largely negotiated between firms and workers within the boundaries of collective agreements between unions and employers' organisations and the Salaried Employees Act (*funktionærloven*) According to the Salaried Employees Act, employers are typically required to provide 1-6 months of notice upon termination of salaried employees, depending on the duration of the employment spell. For non-salary employees, notice requirements are stipulated by collective agreements and are often shorter than those for salaried employees. In an international comparison, employment protection regulations are applied relatively uniformly in Denmark. These features of the Dan-

ish labour market make Denmark an attractive setting for studying how shifts in credit supply affect employment across different worker groups.

In the years prior to the financial crisis, the Danish economy experienced a period of sustained economic growth with steady inflation and low interest rates. During this time, growth in credit extended from Danish banks was high and firms became highly leveraged: in 2007, roughly one-fifth of Danish firms had a debt-to-assets ratio of at least 80 % (Kuchler, 2015). This growth is evident in the trends in total lending (panel (a)) and its annual growth rate (panel (b)) depicted in Figure 1.

Parallel to the growth in credit, Denmark's large and medium-sized banks accumulated growing deposit deficits with a collective deficit of nearly 400 billion DKK in 2007 (roughly 63 billion USD). This deficit was built up over time, a result of a general shift away from mainly deposit-financed lending towards lending financed through short-term funding acquired on foreign inter-bank markets (Rangvid, 2013). Those Danish banks that relied to a greater degree on financing via these markets were more exposed to their fluctuations. Given the global freeze in inter-bank markets that occurred at the onset of the financial crisis, banks' pre-crisis deposit deficits can provide one measure of exposure to the financial crisis. For this reason, a number of empirical studies have looked to banks' pre-crisis ratios of assets to liabilities to capture variation in bank health after the onset of the crisis (Chodorow-Reich, 2014; Jensen and Johannesen, 2017). We follow this literature and use each bank's outstanding loans-to-deposits ratio in 2007 as an indicator of exposure, which we describe in detail in Section 3.2.

The financial crisis, triggered by the sudden and unexpected collapse of Lehman Brothers in September 2008, hit Danish banks and the Danish economy particularly hard. Many banks experienced serious liquidity shortfalls, resulting in a string of bailout packages introduced by the Danish government. Despite the government's efforts, between 2008 and 2013, 62 of 135 banks ceased operations, while many others were absorbed by healthier banks (Rangvid, 2013). The dramatic drop in lending plotted in panel (a) of Figure 1 was matched by a fall in per-capita output of roughly 6 % from the third quarter of 2007 to the third quarter of 2009. At the same time, employment also fell, as shown in panel (b). The fall in employment did not, however, occur uniformly across educational groups. Figure 2 plots trends in employment by educational attainment between 2003 and 2013. The figure shows that aggregate employment

rose for both high- and low-educated workers before the crisis. Subsequently, almost all of the losses in aggregate employment starting in 2007 occurred among workers with at most a primary or secondary level of education (low-educated workers). In contrast, employment of workers with a tertiary level of education (high-educated workers) remained relatively stable, and if anything, increased slightly.

3 Data

3.1 Sources and Sample Selection

The data we use combine administrative information on Danish banks, firms, and individuals. Tax records of all loan and deposit accounts held in Denmark allow us to construct a novel dataset linking banks to their client firms. In this section we provide a brief overview of the data and the sample restrictions we imposed. A detailed account of the raw data and how we constructed the dataset can be found in Appendix A.

We begin by constructing an employer-employee matched dataset from administrative registers maintained and provided by Statistics Denmark. We make use of the Integrated Database for Labour Market Research (IDA) which documents labour market status during the last week of November in each year for all individuals registered in Denmark. Employer identifiers are provided for each job held, and among these, a primary job is identified for each employee. Importantly, IDA also contains information on the percentage of each year an individual spent unemployed, and the years of tenure for each worker-firm match. On the worker side, we supplement the data with comprehensive demographic, educational, and income information from additional administrative registers. On the firm side, we use the Firm-Integrated Database for Labour Market Research (FIDA) to add detailed background and balance sheet information from the Firm Accounting Statistics Register (FIRE) as well as information on the year and month in which firms declared bankruptcy.

Our data's innovating feature is the complete mapping of Danish banks to their client firms using tax records provided by the Danish Tax Authority (SKAT). Each year, all entities in Denmark having issued credit or accepted deposits over the previous 12 months are required to report information on each account open during the year, including the identity of the account holder, the account number, balance, and the sum of interest payments made on the account

over the course of the year.[11] These reportings are used to determine tax obligations and are of accordingly high quality. We collapse the raw data at the firm-bank-account-year level to the firm-bank-year level by summing balances and interest payments across accounts held by the same firm at the same bank in each year. We do not net out loan and deposit accounts. On the bank side, we add detailed annual balance sheet information from the Danish Financial Supervisory Authority (*Finanstilsynet*), as well as monthly data on lending and deposits from Danmarks Nationalbank's MFI statistics.

To arrive at our baseline sample we restrict the data in a number of ways. At the firm level, we begin with all active firms in 2007, excluding those in the financial, agricultural, and public sectors. We then drop all firms with missing balance sheet information in 2007 and those with less than 5 employees, removing many sole proprietorships and small family-run businesses. We also remove a small number of firms registered on the islands of Christansø and Bornholm. Further, we restrict the sample of firms to those that had total outstanding loans of at least 5% of total assets in 2007 to discard those firms for which bank lending constitutes a negligible share of their overall financing.

3.2 Measure of Bank Exposure

Having restricted our sample, we construct a measure of banks' exposure to the financial crisis in the following way. First, for each firm we identify a primary bank in each year following Jensen and Johannesen (2017). If a firm has only one banking relationship in a year, then that bank is its primary bank. If a firm has multiple banking relationships in a year, then the bank at which the firm has the greatest outstanding loan balance is its primary bank in that year. If a firm has multiple banking relationships with equal outstanding loan balances in a year, then the bank at which the firm has the largest balance of deposits is its primary bank in that year. With this procedure we are able to identify a primary bank for all firm-years in the sample. We then remove firms from the sample that had a pre-crisis primary bank that failed between 2008-2011.[12] In many cases these banks were acquired by other banks and clients' accounts were

[11] Unlike loan level data from national credit registries (Bentolila et al., 2018) or compiled databases (Chodorow-Reich, 2014), our data have the limitation of not including information on the terms or stated purposes of the credit issued. Therefore, we are unable to capture changes in credit supply that may occur outside of price and quantity, such as with covenants as discussed in Chodorow-Reich and Falato (2018).

[12] The vast majority of banks that failed were small regional banks such that this restriction does not remove many firms from the sample. The largest banks to fail were Roskilde Bank, the 8th largest bank in Denmark when it was taken over by Danmarks Nationalbank in August 2008, and Amagerbanken, the 11th largest bank

simply transferred over, subjecting these clients to a potentially different treatment than from those banks that did not fail. Together with the previously described sample restrictions, this leaves us with a panel of 13,924 firms covering the years 2004-2011. In 2007, prior to the crisis, the firms in our sample were connected to 83 primary banks.

Banks which financed their lending to larger degree with funding acquired on foreign inter-bank markets experienced severe liquidity shortfalls when these markets froze in 2008. We therefore use each bank's pre-crisis loans-to-deposits ratio as a measure of exposure to the financial crisis. For each bank, we calculate the total outstanding loans-to-deposits ratio in 2007 using banks' balance sheet information. Next, we line up all firms in the baseline sample by the loans-to-deposits ratio of their primary bank in 2007 and split the sample at the median: primary banks of firms at the median and above are defined as exposed, while primary banks of firms below the median firm are defined as non-exposed. In this way we end up with roughly the same number of firms with exposed and non-exposed primary banks in 2007.

3.3 Descriptives

Table 1 presents descriptive statistics of firm characteristics in 2007 by primary bank exposure in 2007. Column 1 reports means and standard deviations for all 13,924 firms in the baseline sample. Columns 2 and 3 report these statistics for firms with non-exposed or exposed primary banks in 2007 respectively. Column 4 reports the ratio of the means (firms with non-exposed primary banks to firms with exposed primary banks), while column 5 reports the p-value from a two-sided t-test against the null hypothesis of equal means between the groups of firms with exposed and non-exposed primary banks in 2007.

For most characteristics in Table 1, firms with exposed pre-crisis primary banks are similar to those with non-exposed pre-crisis primary banks. The top panel of 1 contains basic firm characteristics. Apart from firms with an exposed pre-crisis primary bank being, on average, slightly older, the two groups of firms are similar in terms of the share that are located in the Copenhagen region, the share that are incorporated (referred to as A/S firms in Denmark, or *aktieselskaber*), and size in terms of number of employees. The industrial composition of firms in both groups is also relatively similar as shown in the middle panel. This alleviates concerns that industry-specific shocks may have correlated with exposure of firms' primary banks. Based on

when it was dissolved by the Danish Financial Supervisory Authority in February, 2011.

the balance sheet characteristics in the bottom panel, firms in both groups were also similar in terms of financial health. This alleviates the concern that 'bad' (highly leveraged, low-liquidity, inefficient) firms were systematically matched with 'bad' (exposed) banks prior to the crisis.

Compared to the entire population of firms, our sample is fairly representative in terms of industrial composition, and is comparable to the average Danish firm in terms of indebtedness and liquidity.[13] Given the sample restrictions we impose, the size and annual revenue of the average firm in our sample are slightly larger than the average Danish firm.

4 Evidence of a Shock to Credit Supply

4.1 The Bank-Lending Channel

In this section we provide evidence of the first of two links in the causal chain transmitting bank distress to the real economy. This first link is the 'bank-lending channel' — that exposed banks reduced their supply of credit to firms relative to non-exposed banks. Figure 3 plots mean real lending to domestic non-financial firms, relative to 2007 from exposed and non-exposed banks in our sample. Over the pre-crisis years, both types of banks display similar upward trends in relative lending. By 2009, lending trends had diverged, with exposed banks exhibiting a slight negative growth rate in lending from 2007 to 2008. In the post-crisis years, relative lending from exposed banks remained lower than lending from non-exposed banks.

The trends plotted in Figure 3 are broadly in line with the findings in Kuchler (2012), and consistent with a drop in relative credit supply from exposed banks.[14] They could, however, also be consistent with a drop in relative credit demand from firms borrowing from exposed banks. To identify differential trends in lending, while controlling for firm credit demand, we estimate the following within-firm model for the subset of firms that borrowed from both exposed and

[13]For detailed data on the population of firms in Denmark see the general firm statistics in Tables G1-G7 and the account statistics in Tables REGN2/REGN2X compiled by Statistics Denmark and available at https://www.statistikbanken.dk/.

[14]Kuchler (2012) finds that self-reported credit standards in a sample of large and medium-sized Danish banks were positively related to changes in the interest rate banks were charged on the intra-MFI (inter-bank) market between Q4 2008 and Q2 2012. Further, the author finds evidence that banks adjusted their credit standards largely by adjusting the price of credit rather than collateral requirements.

non-exposed banks in 2007

$$\log(loans_{jbt} + 1) = \theta_{jt} + \phi\Gamma_t \times exposed_b + \delta exposed_b + \eta_{jbt} \quad (1)$$

The dependent variable is the log of outstanding loans firm j holds at bank b in year t. θ_{jt} is a firm-year fixed effect, Γ_t a vector of year dummies (where 2007 is the omitted year), and $exposed_b$ an indicator variable equal to 1 if bank b had a loans-to-deposits ratio above the median firm's primary bank's, and zero otherwise. The vector ϕ contains the coefficients of interest. Its elements indicate the percentage point increase in loan balances at exposed banks relative to non-exposed banks in a given year, relative to 2007. The firm-year fixed effects in equation (1) absorb all confounding shocks at the firm-year level, including firm-year specific credit demand shocks. This is an application of the within estimator proposed by Khwaja and Mian (2008).

Table 2 provides estimates of the within-firm model. The results indicate a clear and persistent shift in borrowing away from exposed towards non-exposed banks, even within firm-years. Column 1 presents estimates of a parsimonious specification of equation (1) without firm-year fixed effects. From 2008 on, firms decreased their outstanding loan balances at exposed banks significantly more than at non-exposed banks. The small and insignificant coefficients prior to 2007 indicate that loan balances at exposed and non-exposed banks exhibited parallel trends in growth prior to the financial crisis. Column 2 adds industry-year, region-year and A/S firm-year fixed effects to the specification estimated in column 1. These terms control for any possible credit demand shocks at the industry and region level, and for A/S firms in particular. Finally, column 3 provides estimates of the full within-firm model including firm-year fixed effects; Figure 4 plots these estimates. The results suggest that by 2009, outstanding loan balances at exposed banks had fallen by roughly 1 percentage point relative to balances at non-exposed banks.

Comparing the results across the specifications in Table 2 sheds light on the direction and magnitude of any potential bias from not accounting for observed and unobserved firm-year specific characteristics. Lacking these controls, one interpretation of the results in column 1 might be that firms borrowing largely from nonexposed banks experienced negative relative credit demand shocks during and after the crisis. This may be due, for instance, to selective sorting of 'bad' firms to 'bad' (exposed) banks. That the post-2007 estimates in columns 2 and 3 are negative and larger in magnitude than the estimates in column 1 — after accounting for

unobserved industry-year, region-year, A/S firm-year, and firm-year heterogeneity — suggests that firms borrowing chiefly from exposed banks in fact exhibited a slight relative increase in credit demand.

4.2 The Firm-Borrowing Channel

In this section we provide evidence of the second of two links in the causal chain transmitting bank distress to the real economy. This second link is the 'firm-borrowing channel' — that firms were unable to perfectly compensate the drop in credit from exposed banks with credit from alternate sources. To estimate the effect of pre-crisis primary bank exposure on debt outcomes, we employ our main differences-in-differences model,

$$y_{jt} = \lambda_j + \gamma\Omega_t + \beta\Omega_t exposed_{j,2007} + \varphi\Omega_t X_{j,2007} + \epsilon_{jt} \tag{2}$$

y_{jt} is an outcome for firm j in year t, λ_j is a firm fixed effect, and Ω_t is a vector of year dummies. $exposed_{j,2007}$ is an indicator equal to one if firm j's primary bank had a loan-to-deposits ratio in 2007 above the median firm's primary bank's, and zero otherwise. $X_{j,2007}$ is a vector of firm-level controls from 2007, including indicators for industry, region, and status as an A/S firm, as well as decile of the pre-crisis distributions of revenue per worker, EBITDA, the current ratio, and the interest rate due across all loans. ϵ_{jt} is the error term clustered at the level of the firm's primary bank in 2007 — the level of treatment.

For simplicity, and given concerns over the precision of estimates in differences-in-differences models with many time periods (Bertrand et al., 2004), we also employ a collapsed version of equation (2), averaging outcomes over the pre-crisis (2005-2007), and crisis/post-crisis (2008-2010) years. In all instances where we employ the collapsed model, we present estimates of the full year-by-year model in Appendix B. In addition to providing a more precise picture of the timing of effects, estimates of the year-by-year model allow us to evaluate the parallel trends assumption, the key identifying assumption of our approach.

In each year some firms exit our sample. We retain these firms in the data and assign a value of zero for monetary and aggregate count variables in years in which the firm is outside of the sample. The estimates of β in equation (2) are therefore estimates of the combined extensive and intensive margin effect of the reduction in credit supply on the particular outcome. Figure

5 shows that firms with an exposed pre-crisis primary bank were slightly more likely to exit the sample in each of the crisis and post-crisis years, but that the differences were small. In Table B3 in Appendix B we present estimates of the full differences-in-differences model for outcome variables capturing firm exit. The results confirm the visual evidence in Figure 5, and show a small and statistically significant effect of exposure of the pre-crisis primary bank on firm exit.

Table 3 provides estimates of the collapsed version of equation (2) for firms' bank debt; Table B1 in Appendix B presents companion estimates of the full year-by-year model. The results show that firms with an exposed pre-crisis bank were largely unable to compensate the drop in credit supply with financing from other banks. Moving from the parsimonious specification in column 1 to the full model in column 4, we progressively add controls for firm characteristics in 2007 and finally firm fixed effects to the model. The estimates in column 4 suggest that bank debt of firms with an exposed pre-crisis primary bank fell by roughly 6% over the crisis/post-crisis years relative to the pre-crisis years. The full year-by-year estimates of this specification are plotted in Figure 6. The estimates of the 'Post x Exposed' coefficient remain relatively stable across columns 1-4, suggesting that potential bias due to observed time varying, and unobserved but fixed firm characteristics is negligible. In columns 5 and 6 we estimate the model for the log of bank debt from the pre-crisis primary bank, and the log of bank debt from all other banks respectively. The estimates show that firms with an exposed pre-crisis primary bank reduced borrowing from their primary bank while slightly increasing borrowing from all other banks. While these estimates of the collapsed version of our model lack precision, the estimates of the full year-by-year model in columns 5 and 6 of Table B1 report statistically significant effects occurring in 2008. Together, these results suggest that firms were unable to completely offset the reduction in credit supplied from their exposed primary banks with credit from other banks. Column 7 restricts the sample to include only those firms that remained active in the years following the financial crisis, producing estimates of the intensive margin response. The results show that roughly half of the overall effect on total borrowing in column 4 is due to firms which exit the sample.

The results presented thus far show that firms with a pre-crisis exposed primary bank exhibited a decrease in the quantity of bank borrowing. Thanks to the detailed nature of our data, we can also estimate the effect of pre-crisis primary bank exposure on the price of bank borrowing. To do so, we follow Jensen and Johannesen (2017) and calculate the effective interest rate for

firm j in year t as

$$eir_{jt} = \frac{interestpaid_{jt}}{0.5(loans_{jt} + loans_{j,t-1})} \tag{3}$$

The effective interest rate is calculated as the sum of interest payments made in year t divided by the average outstanding loan balance at the end of the current and previous years. The denominator is an approximation of the average amount of loans outstanding during the current year and implicitly assumes that loan balances evolve linearly over the course of a year.

The results in column 8 of Table 3 show a clear increase in the price of bank debt for firms with an exposed pre-crisis primary bank. For these firms, the effective interest rate increased by around 0.2 percentage points post-2007, relative to firms with a non-exposed pre-crisis primary bank. This positive effect on the effective interest rate is in line with that found at the household level by Jensen and Johannesen (2017), albeit a little less than one third as large in magnitude. Figure 7 plots the corresponding estimates from the full year-by-year model, providing evidence of pre-crisis parallel trends in the effective interest rate and persistent effects through the crisis and post-crisis years. These results may capture increases in interest rates at firms' existing banks, or any increases firms may experience in newly established banking relationships. Together with the results indicating a relative drop in the quantity of borrowing, evidence of a relative increase in price are indicative of a reduction in credit supply.

Aside from banks, firms may have been able to compensate for the drop in credit supply by acquiring financing from other sources. The results in Table 4 suggest that firms were not able to fully do so. Table 4's columns present estimates of the collapsed version of equation (2) for the subset of firms in the baseline sample with balance sheet figures directly reported by the Danish Tax Authority in each year. Table B2 in Appendix B presents companion estimates of the full year-by-year model. The outcome in columns 1 and 2 is the log of firms' total debt including debt from banks, mortgage-lending institutions, suppliers, and other creditors. The estimate in column 1 of the combined extensive and intensive margin effect of pre-crisis primary bank exposure on total debt is negative, yet imprecisely estimated. The estimate in column 2 is more precisely estimated and suggests that primary bank exposure was associated with a 2% relative decrease in overall debt along the intensive margin.

One particular type of alternate financing we might expect firms to turn to is trade credit. The outcome in column 3 in Table 4 is the log of total debt to suppliers. The estimates show that pre-crisis primary bank exposure was associated with a 3% reduction in debt to suppliers and are consistent with models in which trade credit and debt financing may be compliments (Burkart and Ellingsen, 2004).

5 Effect of the Credit Supply Shock on Real Outcomes

In this section we consider the effects of the reduction in firm credit supply on both firm (5.1) and worker (5.2) outcomes. Section 5.3 uses our estimates to infer the extent to which the credit supply shock drove the fall in aggregate employment. Section 5.4 follows up with a brief discussion of our findings.

5.1 Firm Level Outcomes

In our first set of main results we consider the effect of the reduction in credit supply on firm level employment. To do so, we employ our differences-in-differences model in equation (2) for the log number of employees. Table 5 provides estimates of the collapsed version of our model, while Table B4 in Appendix B provides estimates of the full year-by-year model for each of the same specifications. Though imprecise, the results in column 1 suggest that exposure of the pre-crisis primary bank was associated with a nearly 2% relative decrease in total firm level employment from the pre-crisis to crisis/post-crisis years. The estimated effect in column 1 is a combination of the intensive and extensive margin effects as the sample includes both firms that remained active post-2007 and firms that exited the sample. Firms that exited the sample are recorded as having zero employees for the years in which they are outside of the sample. Column 2 presents estimates of the intensive margin effect on employment using the sample of firms that remained active between 2008-2011. The estimates show that the reduction in credit supply led to a 0.7% fall in employment, statistically significant at the 10% level. This suggests that more than half of the overall effect occurred along the extensive margin. Figure 8 plots the full year-by-year estimates of the specification in column 2, validating the parallel trends assumption and showing that the negative employment effects were almost entirely concentrated in 2008.

Firms with higher pre-crisis liquidity may have been better able to dampen the effects of the reduction in credit supply by using liquid assets to continue to pay workers' wages (Jermann and Quadrini, 2012) or to protect their search capital (the cost of attracting and hiring workers; Boeri et al., 2018). Columns 3 and 4 of Table 5 present estimates of the collapsed version of (2) for employment separately for firms with low and high pre-crisis liquidity, respectively. We measure pre-crisis liquidity using each firm's current ratio (current assets over current liabilities) in 2007. We then split the sample of firms at the median current ratio and define firms with a below-median pre-crisis current ratio as low-liquidity firms, and firms with a pre-crisis current ratio above the median as high-liquidity firms. The estimates in columns 3 and 4 suggest that the negative effect of the reduction in credit supply on employment was overwhelmingly concentrated among firms with low pre-crisis liquidity, in line with previous empirical findings.[15]

In our next set of main results we use the collapsed version of our main empirical model in equation (2) to study how the reduction in credit supply affected the composition of firms' employees. The results are presented in Table 6. Table B5 in Appendix B provides estimates of the full year-by-year model for each of the same specifications. The sample in all columns includes only those firms that remained in the sample in all years between 2008-2011, providing estimates of effects along the intensive margin. The outcome variables in columns 1 and 2 are log employment of managers and non-managers respectively. Information on the managerial status of employees stems from mandatory annual employer reports to the Danish Tax Authority and is available in the raw IDA data. The estimates in columns 1 and 2 suggest that the negative intensive margin employment effects of the reduction in credit supply were largely concentrated among non-managerial workers. Firms with an exposed pre-crisis primary bank reduced employment in non-managerial positions by roughly 1% while employment in managerial positions remained largely unaltered. These results are broadly consistent with the empirical findings of Sforza (2019) and may reflect differences in firing costs (Pfann, 2006), tenure, or expected future productivity (Caggese, Cuñat, and Metzger, 2019).[16]

[15]Berg (2016) finds that the negative effect of a loan application rejection on firm level employment is larger for firms with low liquidity, also measured using the current ratio. Bentolila et al. (2018), however, find that effects of the credit supply shock to Spanish firms on their employment did not vary with pre-crisis liquidity, but did vary with other measures of financial fragility including past defaults and loan rejections, dependence on bank debt, and share of short-term liabilities due within the next year.

[16]The categorisation of firms' managerial hierarchies we use is less detailed than that of Sforza (2019) who finds that firms faced with a credit supply shock reduced employment most among middle managerial positions. However, our findings do confirm a positive effect on the span of control (number of workers per manager) of top managerial workers.

Aside from hierarchical adjustments, firms may have also adjusted the skill composition of their employees. The outcome variables in columns 3 and 4 of Table 6 are log employment of low- and high-educated workers respectively. We classify workers as low- or high-educated based on the highest level of education completed: workers who have completed at most a primary or secondary level education are defined as low-educated, and workers who have completed a tertiary level education are defined as high-educated. While noisy, the estimates suggest that firms largely reduced their employment of low-educated workers in response to the shock to credit supply. A closer look at the timing of the effects from the full year-by-year model in Table B5 in Appendix B shows a significant negative effect on employment of low-educated workers along the intensive margin of roughly 1.2% in 2008. These findings are consistent with Berton et al. (2018) and suggest that firms facing a reduction in credit supply not only downsized, but also changed their mix of labour inputs. In column 5 we study the effect of the shock to credit supply on the average years of employee tenure. The results do not provide evidence of a significant effect, which could be due to a number of reasons. First, employee tenure may not be a relevant dimension upon which firms decide to cut employment when facing a shock to credit supply. Second, short-tenured employees may be let go and partially replaced with new hires with no tenure, resulting in little change in the average years of tenure at the firm level. Third, firms may be inclined to cut employment on both ends of the tenure distribution, in particular workers close to or at the age of retirement, also resulting in minimal change to the average tenure We next turn to estimating the effects of the reduction in firm credit supply on worker-level outcomes in an attempt to distinguish between these alternative explanations.

5.2 Worker Level Outcomes

The results presented thus far suggest that firms facing a reduction in credit supply reduced employment. However, it is possible that workers themselves responded to the shock to their firm's credit supply by seeking employment at other firms. Labour markets are not frictionless markets, where workers affected by a squeeze on employment in one firm can transition directly to a new employer. It is costly to search for employment, in particular during a recessionary period. Consequently, firm's employment decisions should be reflected in worker-level outcomes. To distinguish between these alternatives, we explore how the credit supply shock affected workers' probability of becoming unemployed as an indicator of involuntary separations. In this set of results we estimate the effect of pre-crisis primary bank exposure on workers' probability of

unemployment. To do this, we adapt our main differences-in-differences approach to the worker level with the following model:

$$y_{ijt} = \psi_i + \gamma\Omega_t + \beta\Omega_t exposed_{ij,2007} + \varphi\Omega_t X_{j,2007} + \pi\Omega_t W_{i,2007} + \nu_{ijt} \quad (4)$$

for worker i employed in 2007 at firm j in year t. ψ_i is a worker fixed effect. $exposed_{ij,2007}$ is an indicator variable equal to one if the firm j that worker i was employed at in 2007 had a primary bank that was exposed to the financial crisis in 2007. Ω_t is a vector of year dummies and $X_{j,2007}$ is the same vector of pre-crisis characteristics for firm j as in equation (2). $W_{i,2007}$ is a vector of pre-crisis individual characteristic measured in 2007, including an indicator variable equal to one if the individual had completed tertiary education, and an indicator variable equal to one if the individual was born in Denmark. ν_{ijt} is the error term which we cluster at the level of firm j's primary bank in 2007 — the level of treatment. As with the analyses at the firm level, we primarily refer to estimates of a collapsed version of equation (4) where outcomes over the years 2005-2007 have been averaged in to a pre-crisis period, and outcomes over the years 2008-2010 have been averaged in to a crisis/post-crisis period.

We restrict the sample of workers to include all employees aged 35 to 60 who were employed in 2007 at one of the firms in our baseline sample. We remove a small number of individuals for whom we have missing information in any year between 2004-2011 leaving us with a balanced panel of 259,441 workers. Table 7 reports descriptive statistics in 2007 for the workers in our sample, sorted by whether their employer's pre-crisis primary bank was exposed. While workers employed at firms with an exposed pre-crisis primary bank are, on average, slightly older, more educated, tenured, experienced, and more likely to be male and born in Denmark, the differences between these averages across groups are relatively small when considering the ratio of means. A large body of research shows that individuals sharing the characteristics of workers at firms with exposed pre-crisis primary banks are more attached to the labour market and fare better during recessions.[17] As such, the balance of characteristics between workers at firms with exposed and

[17]See Hoynes et al. (2012) for an overview in the US context; Andersen (2017) in the Danish context. Clark and Summers (1981), and more recently Jaimovich and Siu (2009) provide evidence that volatility of employment and hours worked is higher for young workers than prime-aged and elderly workers across the G7 countries. Hoynes (1999) shows that employment and earnings of less educated, non-white, and particularly female workers are more cyclically volatile using US data. Bratsberg et al. (2004) use Norwegian register data to show that the earnings of immigrants from non-OECD countries are more sensitive to local unemployment than that of natives. Orrenius and Zavodny (2010) show that Mexican immigrants in the US were particularly hard hit by the Great Recession both overall and within education groups. Arozamena and Centeno (2006) present empirical evidence that the

non-exposed pre-crisis primary banks may serve to dampen any potential negative effects of the reduction in credit supply on workers' labour market outcomes.

Table 8 presents estimates of the collapsed version of equation (4) for workers' risk of unemployment. Table B6 in Appendix B reports companion estimates of the full year-by-year model. The outcome variable in all columns is an indicator equal to 1 if worker i was unemployed at any time during year t, and zero otherwise.[18] The estimates in column 1 suggest that workers employed at firms with an exposed pre-crisis primary bank were 0.4% more likely to experience a period of unemployment between 2008-2010 than those employed at firms with a non-exposed pre-crisis primary bank. This estimated average effect for all workers in the sample masks considerable heterogeneity by position in the firm and educational attainment. In columns 2 and 3, we estimate the model for unemployment separately for workers employed in 2007 in managerial and non-managerial positions respectively. The results clearly show that the effect of the reduction in credit supply on unemployment was highly concentrated among workers in non-managerial positions. Being employed at a firm with an exposed pre-crisis primary bank is associated with a 0.4% increase in the likelihood of experiencing unemployment post-2007 for workers in non-managerial positions. Similarly, total effects at the worker level are shown to be driven by low-educated workers. Exposure of the pre-crisis primary bank is associated with a 0.4% increase in the likelihood for low-educated workers, but does not seem to have an effect on the risk of unemployment for high-educated workers.

Panels (a) and (b) of Figure 9 plot the estimates from the full year-by-year model for an indicator of unemployment among non-managerial workers and low-educated workers respectively. The full set of results behind all panels in Figure 9, including the estimated impacts for managerial workers and high-educated workers, is available in B6 in Appendix B. The small and insignificant estimates on the exposure-year interaction terms for the years prior to 2007 lend credibility to our identifying assumption of pre-treatment parallel trends in unemployment. The magnitude and significance of the estimates in 2008 and 2009 suggest that the bulk of the effect

wage-unemployment rate elasticity is lower for more tenured workers. Hershbein and Kahn (2018) find that firms increased education and experience requirements, within both occupation and firm, during the 2008-09 financial crisis.

[18] We construct this outcome variable using information on the fraction the year that an individual received unemployment benefits, available in the IDA database. This information is based on records of unemployment that were sourced until 2007 from the *Centrale register for arbejdsmarkedsdata* (CRAM), and from 2008 on from *Personer uden Ordinaer Beskaeftigelse* statistics

of the reduction in credit supply occurred in these years. Our results at the worker level provide evidence that firms facing a credit shock did indeed shed employment.

We further study how the effects on worker unemployment vary by worker tenure. Table 9 presents estimates of our worker level model separately for short-(0-2 years), mid-(3-8 years), and long-tenured (9+ years) workers. The results show that effects were highly concentrated on short-tenured workers, as these workers experienced a 0.5% increase in the probability of unemployment over the period 2008-2010. The results of the full year-by-year model in Table B7 in Appendix B show that effects for short-tenured workers were largest in magnitude in 2009 and remained persistently high through 2011. We also find evidence of a smaller, less precisely estimated effect on unemployment in 2008 for long-tenured workers. Panel (c) of Figure 9 plots the estimates from the full year-by-year model for an indicator of unemployment among short-tenured workers. The small and insignificant estimates on the exposure-year dummy interaction terms for the years prior to 2007 lend credibility to our identifying assumption of pre-treatment parallel trends in unemployment. The magnitude and significance of the estimates in 2008 and 2009 suggest that the bulk of the effect of the reduction in credit supply occurred in these years.

5.3 Aggregate Implications

Following Chodorow-Reich (2014), we can use our estimates in Section 5.1 together with the following two assumptions to infer the extent to which the shock to credit supply drove the fall in aggregate employment from 2007-2008 in our sample. These are that,

1. The total effect of the shock to credit supply on employment is the sum of the direct effects at the firm level.

2. Non-exposed banks did not shift their supply of credit.

Both assumptions are, indeed, quite strong. To the extent that these assumptions do not hold, however, our simple calculations of the aggregate effect are likely to represent a lower bound on the true effect on employment in our sample. For instance, the true aggregate effect may also include indirect effects on firms that were not attached to exposed banks through, for example, supply chains and network effects. If non-exposed banks also cut their supply of credit, then the counterfactual employment we calculate for firms with non-exposed banks will overstate employment at these firms and understate the true aggregate effect.

Formally, let us first define counterfactual log employment for firm j in 2008 if its pre-crisis primary bank was non-exposed

$$\begin{aligned}\tilde{y}_{j,2008}(exposed_{j,2007}) &\equiv E[y_{j,2008}|exposed_{j,2007}=0] \\ &\equiv \hat{y}_{j,2008} - (\hat{\beta}_{2008} \times exposed_{j,2007})\end{aligned}$$

$\hat{y}_{j,2008}$ is the fitted value of log employment in 2008 from our main differences-in-differences model. $exposed_{j,2007}$ is an indicator equal to one if the firm's primary pre-crisis bank was exposed to the financial crisis. $\hat{\beta}_{2008}$ is the estimate from our main differences-in-differences model of the coefficient on the interaction term between $exposed_{j,2007}$ and a year dummy for the year 2008. The total decrease in employment (in levels) from 2007 to 2008 due to the shock to credit supply is then

$$\sum_{exposed_{j,2007}=1} \exp(\hat{y}_{j,2008}) - \sum_{exposed_{j,2007}=1} \exp(\tilde{y}_{j,2008})$$

That is, for firms with an exposed pre-crisis primary bank, we sum predicted employment and subtract the sum of counterfactual employment. The share of the total decrease in employment from 2007-2008 that can be explained by the shock is then

$$\frac{\sum_{exposed_{j,2007}=1} \exp(\hat{y}_{j,2008}) - \sum_{exposed_{j,2007}=1} \exp(\tilde{y}_{j,2008})}{\sum_j \exp(y_{j,2008}) - \sum_j \exp(y_{j,2007})} \tag{5}$$

A summary of our calculations is presented in Table 10. Column 1 shows the calculations for total employment, while column 2 focuses on employment of low-educated workers. From 2007-2008, total employment at firms that did not exit our sample fell by 38,410 employees of which 36,195 were low-educated workers. These represent decreases in employment by 9.1% and 10% respectively. Following the approach outlined above, our estimates of the impact of the shock to credit supply can explain about 4.2% of the total fall in employment at firms that did not exit our sample, and around 4.9% of the fall in the employment of low-educated workers at these firms. Despite employing a different estimation approach to a different context, the share of the in-sample fall in employment that our estimates can explain is comparable to that presented by Chodorow-Reich, 2014, who explains roughly 3.2%-4% of the fall in in-sample employment using data for the US.

5.4 Discussion

The results presented in Section 5.1 suggest that the reduction in credit supply caused firms to reduce employment, in line with previous empirical findings. However, it remains an open question which mechanisms drive the link between credit and employment. The theoretical literature offers a number of possibilities. Petrosky-Nadeau (2014), Petrosky-Nadeau and Wasmer (2013), and Wasmer and Weil (2004) introduce credit markets with search frictions into a standard search and matching model of the labour market. With greater frictions in the credit market, it is harder for firms to access credit, and they do not post as many vacancies. Monacelli et al. (2011) focus instead on the wage-bargaining process, building a model in which higher debt reduces the net surplus over which firms and workers negotiate. Access to credit allows firms to accumulate more debt and bargain for lower wages, increasing the incentive to create jobs. More recently a number of papers have focused on the role of liquidity. Garín (2015), Jermann and Quadrini (2012), and Melcangi (2017) propose models in which financial frictions constrain firms' holdings of liquid assets which are needed to pay employees' salaries. Boeri et al. (2018) incorporate firm credit constraints in the form of limited pledgeability into a standard job search model where firms hold liquid assets for precautionary reasons.[19] Frictions in the credit market lead firms to increase the amount of liquidity they hold at the expense of investing in greater capacity and more employees. Our findings that the employment impacts of the reduction in credit supply were greatest for firms with low pre-crisis liquidity support these theories.

At the firm level, we further find that credit supply-induced cuts to employment occurred largely amongst employment of non-managerial and low-educated workers. These results suggest that firms not only downscaled in terms of their use of labour, but also changed the skill composition and hierarchical structure of their workforce. The extent to which the above mentioned mechanisms are of greater relevance for employment in non-managerial positions and among low-educated workers may help explain our findings. For instance, firms that become strapped for liquidity due to a reduction in credit supply may alter their demand for production inputs in such a way that forces them to reduce immediate costs at the expense of future productivity (Caggese and Cuñat, 2008; Caggese, Cuñat, and Metzger, 2019; Eisfeldt and Rampini,

[19] Limited pledgeability introduced by Holmstrom and Tirole (2011) and Tirole (2011) captures the idea that firms can only commit to repay a portion of expected future income when securing financing. This may be the case when part of the income from a particular project or investment is non-pecuniary in nature, or cannot otherwise easily be transferred to the creditor. In addition, the firm must have a sufficiently large stake in the outcome of the project or investment to have the proper incentives to maximise the expected future gain.

2006). If adjustment costs for employment of low-educated, non-managerial workers are relatively low, this may lead firms to cut employment more among workers in these groups (Oi, 1962; Rosen, 1968). Employment of low-educated, non-managerial workers may also be more negatively affected if wages for these workers are more rigid (due to binding wage floors) than for high-educated, managerial workers (Moser et al., 2020).

Our results at the firm level further suggest a small and insignificant negative effect of the shock to credit supply on the average years of employee tenure. This result, however, masks significant, heterogeneous employment effects along the employee tenure distribution. In general, results at the firm level do not necessarily imply corresponding effects at the worker level. Small or no changes in a firms' stock of employees can mask larger flows in and out of a firms' workforce. At the worker level, we find a modest positive effect on unemployment for long-tenured workers, as well as a larger, more persistent effect for short-tenured workers. These results may be a reflection of firing costs that increase with tenure (Cavalcanti, 2004), higher wages for more tenured workers (Mincer and Jovanovich, 1979), or greater firm-specific human capital — and higher productivity — among longer-tenured workers (Shaw and Lazear, 2008). The apparent persistence of effects for short-tenured workers may indicate longer-term scarring effects of job loss (Ouyang, 2009), and are consistent with models in which the tenure of a discontinued employment relationship signals worker ability to potential future employers (Greenwald, 1986).

When interpreting our findings, it is important to keep in mind that our results are estimates of relative, partial equilibrium effects. For instance, our estimates of the elements of the β vector in equation (2) tell us how much *more* borrowing and employment fell at firms with an exposed pre-crisis primary bank than at firms with a non-exposed pre-crisis primary bank. Similarly, our estimates of the elements of the β vector in equation (4) tell us how much *more* unemployment rose for workers employed pre-crisis at firms with an exposed pre-crisis primary bank compared to workers employed pre-crisis at firms with a non-exposed pre-crisis primary bank. These results do not rule out drops in employment or increases in unemployment associated with non-exposed pre-crisis primary banks.

6 Conclusion

In this paper, we show that pressures within the banking system can spread to the real economy with significant, and heterogeneous, impacts on firms and workers. We use a novel bank-firm-worker matched dataset built from Danish administrative and tax records to study the effects of bank distress during the 2008-2009 financial crisis. Prior to the crisis, some banks increased their reliance on funding acquired via inter-bank markets, leaving them exposed to liquidity shortfalls once these markets froze in the autumn of 2008. Consistent with the literature, we show that the transmission of this shock from banks to firms occurred via two links in a causal chain. First, we document the bank-lending channel, whereby banks that were particularly exposed to the crisis reduced their supply of credit to firms. Next, we document the firm-borrowing channel whereby firms that were primarily connected to exposed banks were unable to fully compensate for the reduction in credit supply with credit from alternate sources.

In line with previous empirical studies, we find significant effects of the reduction in credit supply on firm-level employment. Firms primarily connected to exposed banks before the crisis reduced employment by roughly 2% relative to firms primarily connected to non-exposed banks before the crisis. Back-of-the-envelope calculations suggest that the reduction credit supply can explain roughly 6% of the overall reduction in employment from 2007-2008. Just over half of the total effect on employment occurred due to firm exit. The negative effect of pre-crisis primary bank exposure on employment was greatest for firms with low pre-crisis liquidity, and concentrated on employment in non-managerial positions. Further, we present evidence that exposure of the pre-crisis primary bank was associated with a significant reduction in employment of low-educated workers. These findings highlight access to credit as a potentially important factor behind the large losses in employment of low-educated workers observed in the data during the financial crisis. At the worker level, the impact of the reduction in firms' credit supply varied with employee characteristics. We find that amplifying effects on unemployment were driven by non-managerial, low-educated, and short-tenured workers.

Our findings of firm level employment effects using Danish data are consistent with those for the US (Chodorow-Reich, 2014) and Germany (Popov and Rocholl, 2018). Despite Denmark's relatively generous social security system, Danish labour markets are characterised by relatively little employment protection and high mobility. These features make Denmark an ideal setting

for our study. The magnitude of our findings may be specific to the level of employment protection in Denmark and may vary when applied to other settings with more or less flexible labour markets. While employment protection for the average employee may vary across countries, Denmark's employment-protection regulations are applied relatively uniformly, ensuring that our results regarding the heterogeneous employment impacts are not driven by differences in employment protection. At the same time, while earnings inequality has been steadily increasing in Denmark, it remains relatively low seen in an international comparison (Leth-Petersen and Saeverud, 2023). Despite this, our findings suggest that credit supply may play a key role in driving unequal labour market dynamics between the more and less educated workers. This link may be even more prominent in countries characterised by higher levels of inequality.

Taken together, our findings shed light on the interaction of frictions in credit and labour markets and highlight the role that provision of credit plays in explaining employment dynamics. Due to frictions in credit markets, firms are unable to fully and costlessly offset reductions in borrowing capacity from some creditors with additional financing from others — even when their underlying creditworthiness has not changed. Frictions in labour markets also hinder workers affected by reduced credit supply from finding new employment without experiencing periods of unemployment. Our findings document these consequences and highlight the importance of policies such as capital requirements for banks or targeted labour market policies aimed at preventing bank distress and cushioning the impacts of the real effects of credit supply shocks.

References

Abildgren, K., Jensen, C. M., Kristoffersen, M. S., Kuchler, A., Hansen, M. N. S., & Skakoun, O. (2014). Corporate Capital Structure, Productivity and Access to Finance. *Danmarks National Bank Monetary Review*, (4), 61–77.

Alfaro, L., García-Santana, M., & Moral-Benito, E. (2019). *On the Direct and Indirect Real Effects of Credit Supply Shocks*, NBER Working Paper No. 25458.

Andersen, T. M. (2017). The Danish Labor Market, 2000–2016. *IZA World of Labor*, *404*.

Arozamena, L., & Centeno, M. (2006). Tenure, Business Cycle and the Wage-Setting Process. *European Economic Review*, *50*(2), 401–424.

Bentolila, S., Jansen, M., & Jiménez, G. (2018). When Credit Dries Up: Job Losses in the Great Recession. *Journal of the European Economic Association*, *16*(3), 650–695.

Berg, T. (2016). *Got Rejected? Real Effects of Not Getting a Loan* (No. 1960), ECB Working Paper No. 1960.

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

Berton, F., Mocetti, S., Presbitero, A. F., & Richiardi, M. (2018). Banks, Firms, and Jobs. *Review of Financial Studies*, *31*(6), 2113–2156.

Bertrand, M., Duflo, E., & Mullainathan, S. (2004). How Much Should we Trust Differences-in-Differences Estimates? *Quarterly Journal of Economics*, *119*(1), 249–275.

Bobbio, E., & Bunzel, H. (2018). *The Danish Matched Employer-Employee Data*, Aarhus University Working Paper No. 3.

Boeri, T., Garibaldi, P., & Moen, E. R. (2018). Financial Constraints in Search Equilibrium: Mortensen Pissarides meet Holmstrom and Tirole. *Labour Economics*, *50*, 144–155.

Bratsberg, B., Barth, E., & Raaum, O. (2004). Identifying Earnings Assimilation of Immigrants under Changing Macroeconomic Conditions. *Scandinavian Journal of Economics*, *106*(1), 1–22.

Burkart, M., & Ellingsen, T. (2004). In-Kind Finance: A Theory of Trade Credit. *American Economic Review*, *94*(3), 569–590.

Caggese, A., & Cuñat, V. (2008). Financing Constraints and Fixed-Term Employment Contracts. *Economic Journal*, *118*(533), 2013–2046.

Caggese, A., Cuñat, V., & Metzger, D. (2019). Firing the Wrong Workers: Financing Constraints and Labor Misallocation. *Journal of Financial Economics*, *113*(3), 589–607.

Campello, M., Graham, J. R., & Harvey, C. R. (2010). The Real Effects of Financial Constraints: Evidence from a Financial Crisis. *Journal of Financial Economics*, *97*(3), 470–487.

Casey, E., & O'Toole, C. M. (2014). Bank Lending Constraints, Trade Credit and Alternative Financing During the Financial Crisis: Evidence from European SMEs. *Journal of Corporate Finance*, *27*, 173–193.

Cavalcanti, T. V. d. V. (2004). Layoff Costs, Tenure, and the Labor Market. *Economics Letters*, *83*(4), 383–390.

Chodorow-Reich, G. (2014). The Employment Effects of Credit Market Disruptions: Firm-level Evidence from the 2008-9 Financial Crisis. *Quarterly Journal of Economics*, *129*(1), 1–59.

Chodorow-Reich, G., & Falato, A. (2018). *The Loan Covenant Channel: How Bank Health Transmits to the Real Economy*, mimeo.

Cingano, F., Manaresi, F., & Sette, E. (2016). Does Credit Crunch Investment Down? New Evidence on the Real Effects of the Bank-Lending Channel. *Review of Financial Studies*, *29*(10), 2737–2773.

Clark, K. B., & Summers, L. H. (1981). Demographic Differences in Cyclical Employment Variation. *Journal of Human Resources*, *16*(1), 61–79.

Cortes, G. S., Van Doornik, B., & Silva, T. C. (2019). *Credit Shock Propagation in Firm Networks: Evidence from Government Bank Credit Expansions*, mimeo.

Duchin, R., Ozbas, O., & Sensoy, B. A. (2010). Costly External Finance, Corporate Investment, and the Subprime Mortgage Credit Crisis. *Journal of Financial Economics*, *97*(3), 418–435.

Eisfeldt, A. L., & Rampini, A. A. (2006). Capital Reallocation and Liquidity. *Journal of Monetary Economics*, *53*(3), 369–399.

Garcia-Appendini, E., & Montoriol-Garriga, J. (2013). Firms as Liquidity Providers: Evidence from the 2007-2008 Financial Crisis. *Journal of Financial Economics*, *109*(1), 272–291.

Garín, J. (2015). Borrowing Constraints, Collateral Fluctuations, and the Labor Market. *Journal of Economic Dynamics and Control*, *57*, 112–130.

Greenaway, D., Guariglia, A., & Kneller, R. (2007). Financial Factors and Exporting Decisions. *Journal of International Economics*, *73*(2), 377–395.

Greenwald, B. C. (1986). Adverse Selection in the Labour Market. *Review of Economic Studies*, *53*(3), 325–347.

Greenwald, B. C., & Stiglitz, J. E. (1990). *Asymmetric Information and the New Theory of the Firm: Financial Constraints and Risk Behaviour*, NBER Working Paper No. 3359.

Hall, B. H. (2002). The Financing of Research and Development. *Oxford Review of Economic Policy*, *18*(1), 35–51.

Hershbein, B., & Kahn, L. B. (2018). Do Recessions Accelerate Routine-Biased Technological Change? Evidence from Vacancy Postings. *American Economic Review*, *108*(7), 1737–1772.

Hochfellner, D., Montes, J., Schmalz, M., & Sosyura, D. (2015). *Winners and Losers of Financial Crises: Evidence from Individuals and Firms*, mimeo.

Holmstrom, B., & Tirole, J. (2011). *Inside and Outside Liquidity*. MIT Press.

Hong, H., Kubik, J. D., & Scheinkman, J. A. (2012). *Financial Constraints on Corporate Goodness* (No. 18476), NBER Working Paper No. 18476.

Hoynes, H. (1999). *The Employment, Earnings, and Income of Less Skilled Workers Over the Business Cycle*, NBER Working Paper No. w7188.

Hoynes, H., Miller, D. L., & Schaller, J. (2012). Who Suffers During Recessions? *Journal of Economic Perspectives*, *26*(3), 27–48.

Huber, K. (2018). Disentangling the Effects of a Banking Crisis: Evidence from German Firms and Counties. *American Economic Review*, *108*(3), 868–898.

Iyer, R., Peydró, J. L., Da-Rocha-Lopes, S., & Schoar, A. (2014). Interbank Liquidity Crunch and the Firm Credit Crunch: Evidence from the 2007-2009 Crisis. *Review of Financial Studies*, *27*(1), 347–372.

Jaimovich, N., & Siu, H. E. (2009). The Young, the Old, and the Restless: Demographics and Business Cycle Volatility. *American Economic Review*, *99*(3), 804–826.

Jaimovich, N., & Siu, H. E. (2020). Job Polarization and Jobless Recoveries. *Review of Economics and Statistics*, *102*(1), 129–147.

Jensen, T. L., & Johannesen, N. (2017). The Consumption Effects of the 2007–2008 Financial Crisis: Evidence from Households in Denmark. *American Economic Review*, *107*(11), 3386–3414.

Jermann, U., & Quadrini, V. (2012). Macroeconomic Effects of Financial Shocks. *American Economic Review*, *102*(1), 238–271.

Khwaja, A. I., & Mian, A. (2008). Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market. *American Economic Review*, *98*(4), 1413–1442.

Klemperer, P. (1987). Markets with Consumer Switching Costs. *Quarterly Journal of Economics*, *102*(2), 375–394.

Kuchler, A. (2012). *The Interplay Between Credit Standards and Credit Demand: Microeconometric Evidence from Denmark* (November), Danmarks Nationalbank Working Paper No. 82.

Kuchler, A. (2015). Firms' Leverage and Investment. *Danmarks Nationalbank Monetary Review*, (3), 63–72.

Leth-Petersen, S., & Saeverud, J. (2023). Inequalities in Denmark: 1987-2021. *Country Studies: Inequalities in Europe and North America. Institute for Fiscal Studies.*

Lund, C. G., & Vejlin, R. (2015). *Documenting and Improving the Hourly Wage Measure in the Danish IDA Database* (No. 6), Aarhus University Economics Working Paper 2015-06.

Melcangi, D. (2017). *The Marginal Propensity to Hire* (December), mimeo.

Mincer, J., & Jovanovich, B. (1979). *Labor Mobility and Wages* (No. 357), NBER Working Paper No. 357.

Modigliani, F., & Miller, M. H. (1958). The Cost of Capital, Corporation Finance and the Theory of Investment. *American Economic Review*, *48*(3), 261–297.

Monacelli, T., Quadrini, V., & Trigari, A. (2011). *Financial Markets and Unemployment*, NBER Working Paper No. 17389.

Moser, C., Saidi, F., Wirth, B., & Wolter, S. (2020). *Credit Supply, Firms, and Inequality*, mimeo.

Oi, W. Y. (1962). Labor as a Quasi-Fixed Factor. *Journal of Political Economy*, *70*(6), 538–555.

Orrenius, P. M., & Zavodny, M. (2010). Mexican Immigrant Employment Outcomes Over the Business Cycle. *American Economic Review*, *100*(2), 316–320.

Ouyang, M. (2009). The Scarring Effect of Recessions. *Journal of Monetary Economics*, *56*(2), 184–199.

Paravisini, D., Rappoport, V., & Schnabl, P. (2017). *Specialization in Bank Lending: Evidence from Exporting Firms* (No. 1492), CEP Discussion Paper No. 1492.

Peek, J., & Rosengren, E. S. (1997). The International Transmission of Financial Shocks: The Case of Japan. *American Economic Review*, *87*(4), 495–505.

Peek, J., & Rosengren, E. S. (2000). Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States. *American Economic Review*, *90*(1), 30–45.

Petersen, M. A., & Rajan, R. G. (1997). Trade Credit: Theories and Evidence. *Review of Financial Studies*, *10*(3), 661–691.

Petrosky-Nadeau, N. (2014). Credit, Vacancies and Unemployment Fluctuations. *Review of Economic Dynamics*, *17*(2), 191–205.

Petrosky-Nadeau, N., & Wasmer, E. (2013). The Cyclical Volatility of Labor Markets under Frictional Financial Markets. *American Economic Journal: Macroeconomics*, *5*(1), 193–221.

Pfann, G. A. (2006). Downsizing and Heterogeneous Firing Costs. *Review of Economics and Statistics*, *88*(1), 158–170.

Popov, A., & Rocholl, J. (2018). Do Credit Shocks Affect Labor Demand? Evidence for Employment and Wages During the Financial Crisis. *Journal of Financial Intermediation*, *36*, 16–27.

Rangvid, J. (2013). *The Financial Crisis in Denmark - Causes, Consequences, and Lessons* (tech. rep.). Danish Ministry for Business and Growth.

Rosen, S. (1968). Short-Run Employment Variation on Class-I Railroads in the U.S., 1947-1963. *Econometrica*, *36*(3/4), 511–529.

Schwert, M. (2018). Bank Capital and Lending Relationships. *Journal of Finance*, *73*(2), 787–830.

Sforza, A. (2019). *Shocks to the Organization of the Firm: Who Pays the Bill?*, mimeo.

Sharpe, S. A. (1990). Asymmetric Information, Bank Lending and Implicit Contracts: A Stylized Model of Customer Relationships. *Journal of Finance*, *45*(4), 1069–1087.

Shaw, K., & Lazear, E. P. (2008). Tenure and output. *Labour Economics*, *15*(4), 704–723.

Stein, J. C. (2003). Agency, Information, and Corporate Investment. In *Handbook of the economics of finance* (pp. 111–165, Vol. 1). Elsevier.

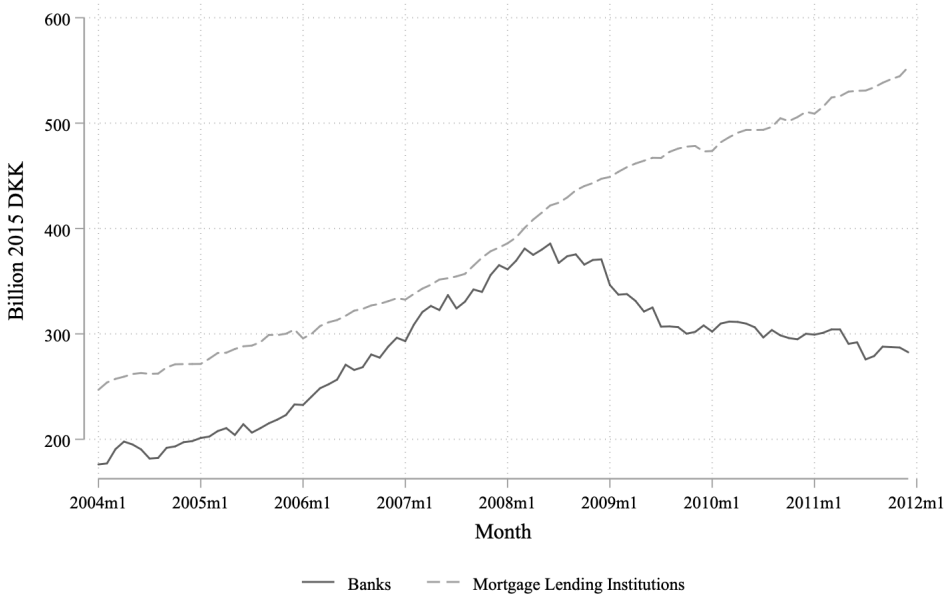
Wasmer, E., & Weil, P. (2004). The Macroeconomics of Labour and Credit Market Imperfections. *American Economic Review*, *94*(4), 944–963.

Wilner, B. S. (2000). The Exploitation of Relationships in Financial Distress: The Case of Trade Credit. *Journal of Finance*, *55*(1), 153–178.

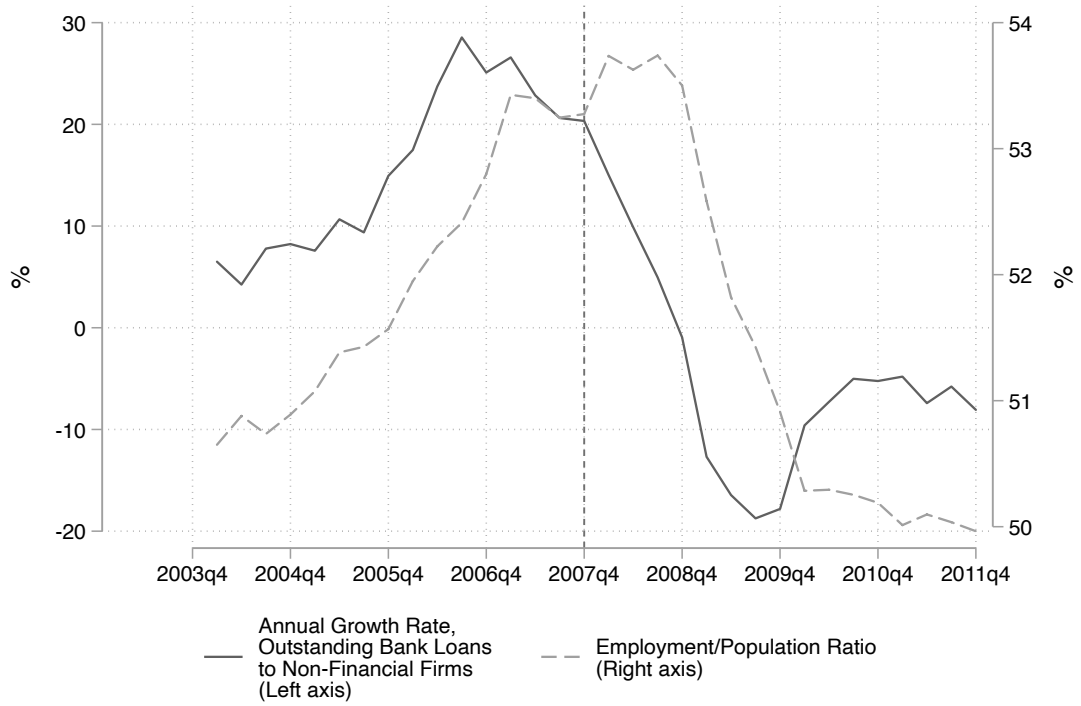
Tables and Figures

Figure 1: Lending to Danish Non-Financial Corporations, 2004-2011

(a) Total Lending

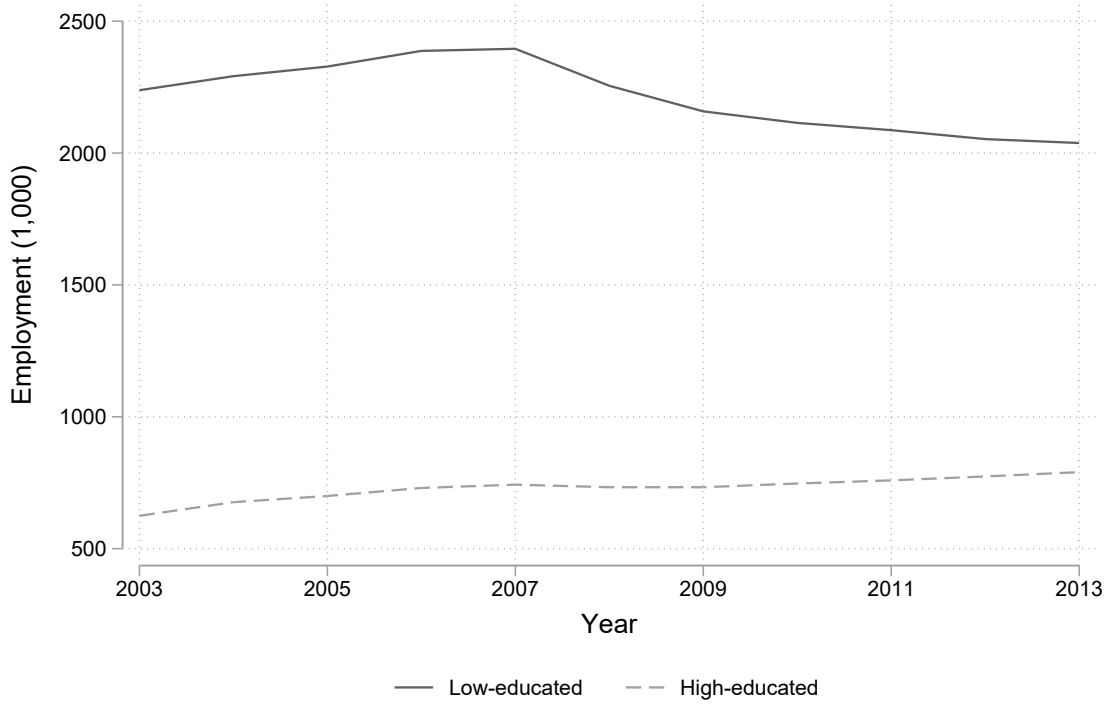


(b) Lending Growth and Employment



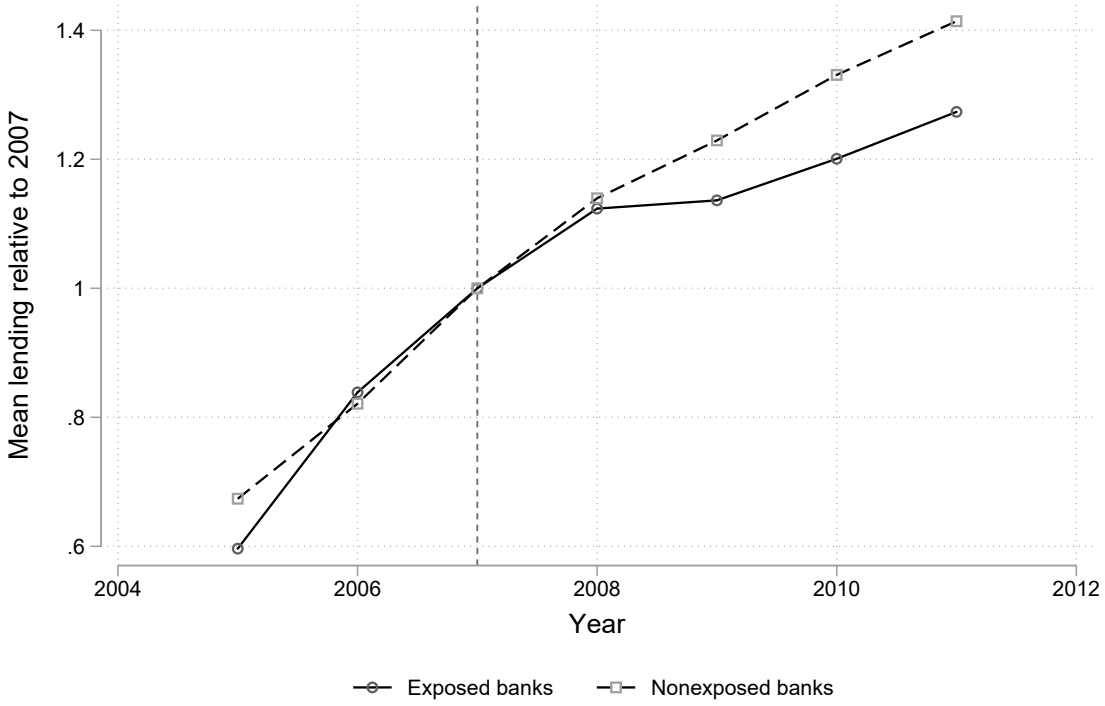
Source: Danmarks Statistik
Notes: Panel (a) plots real monthly total lending from Danish banks and mortgage lending institutions to Danish non-financial corporations between January 2004 and December 2011 (series DNMUDL and PRIS117 respectively). Panel (b) plots the annualised growth rate of of outstanding bank loans from Danish banks to Danish non-financial firms against the left y-axis and the employment/population ratio against the right y-axis.

Figure 2: Total Employment by Educational Attainment, 2003-2013



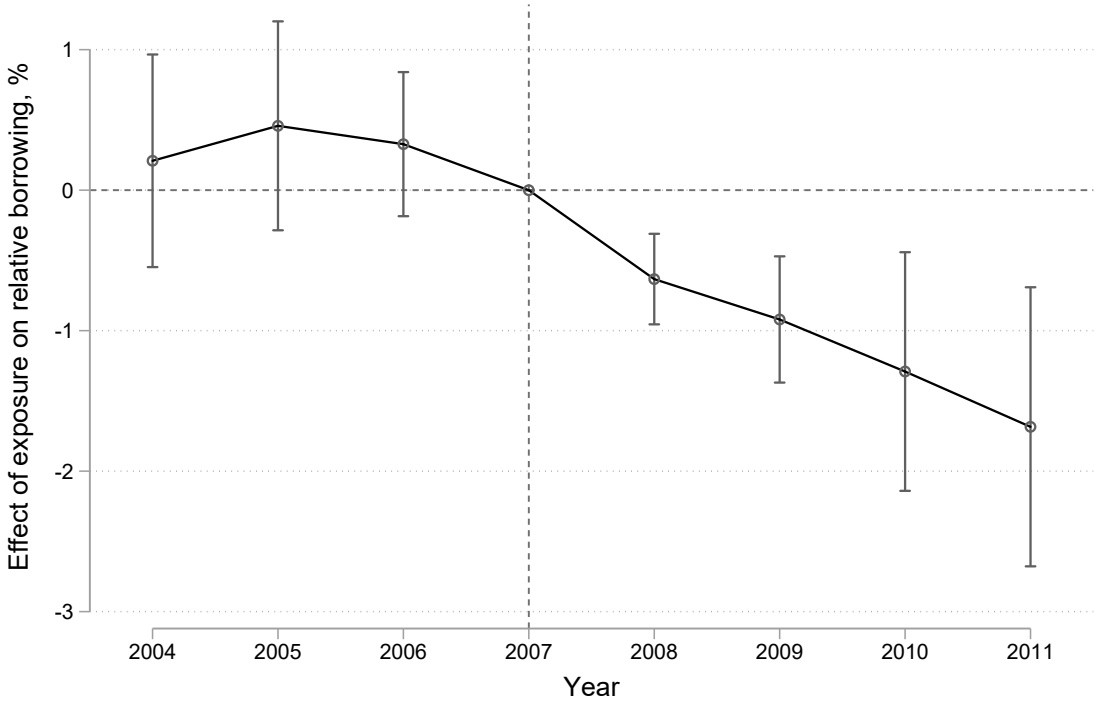
Source: Danmarks Statistik
Notes: This figure plots total employment during the last week of November in each year by educational attainment. Low-educated employees are those workers who have at most completed a primary- or secondary-level education. High-educated employees are those workers who have completed a tertiary-level education.

Figure 3: Mean Lending Relative to 2007



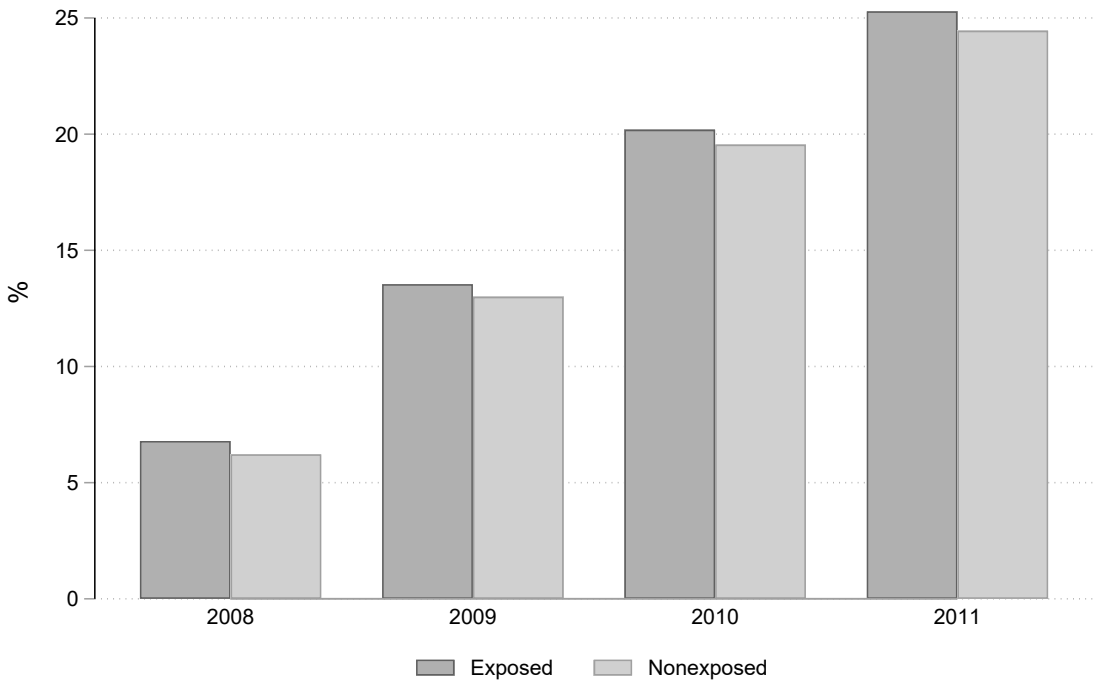
Source: Danmarks Nationalbank - MFI statistics
Notes: This figure plots mean real lending relative to 2007 to Danish non-financial firms from exposed and non-exposed banks in our sample. The banks in the sample include those banks identified as primary banks for the firms in our sample following the steps outlined in Sections 3.1 and 3.2. Further, we restrict the sample of banks to those with positive lending in each year between 2005 and 2011. Exposed banks are those that had loans-to-deposits ratio in 2007 at and above the median firm's primary bank's; non-exposed banks are those with a loans-to-deposits ratio in 2007 below the median firm's primary bank's. Banks' relative lending to 2007 has been winsorized at the 5th and 95th percentiles in each year.

Figure 4: Within-Firm Model Estimates of the Effect of Pre-Crisis Exposure on Firms' Bank-Specific Outstanding Loans



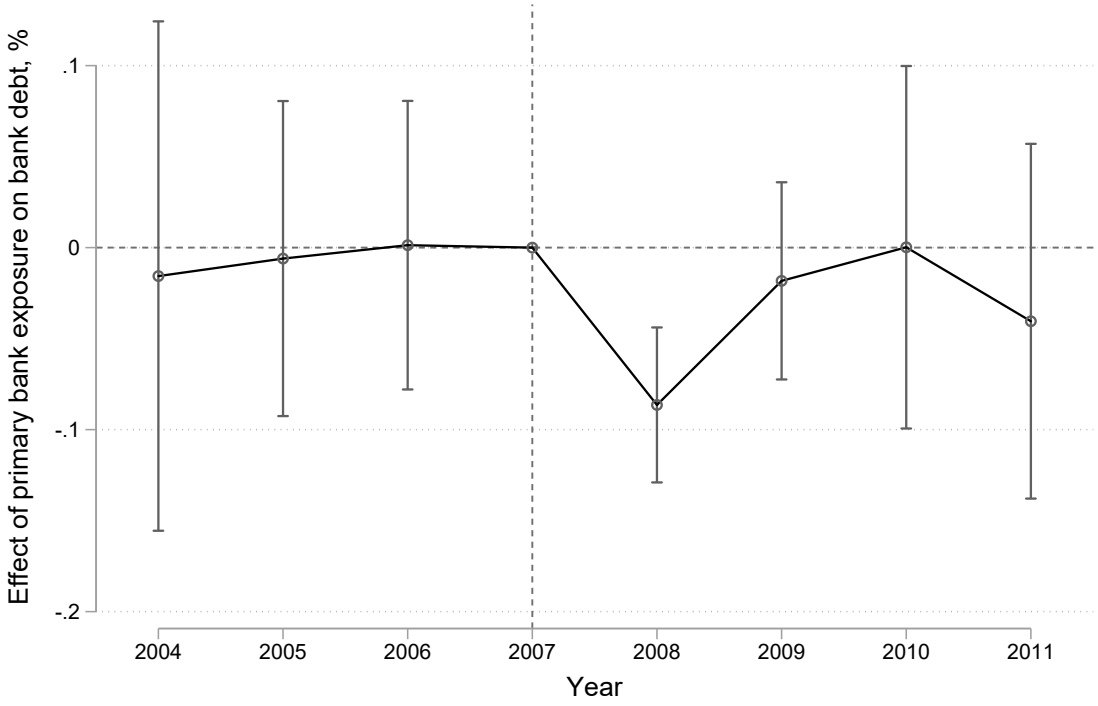
Notes: This figure plots OLS estimates of the within-firm model including firm-year fixed effects. The dependent variable is the log of outstanding loans (10,000 2005 DKK) held by a firm in each year at each bank it had a relationship with in 2007 plus one. The points plotted represent estimates of the coefficients on interaction terms between year dummies and an indicator for bank exposure in 2007 as defined in Section 3.2. These estimates correspond to those in column 3 of Table 2. The sample includes all firm-bank relationships with an average loan balance of at least 2% of average total assets over the years 2004-2011 for firms active in each of those years. Vertical bars represent 95% confidence intervals, where the standard errors have been clustered at the bank level (the level of treatment).

Figure 5: Cumulative Percentage of Firms that Exit the Sample by Exposure of the Pre-Crisis Primary Bank



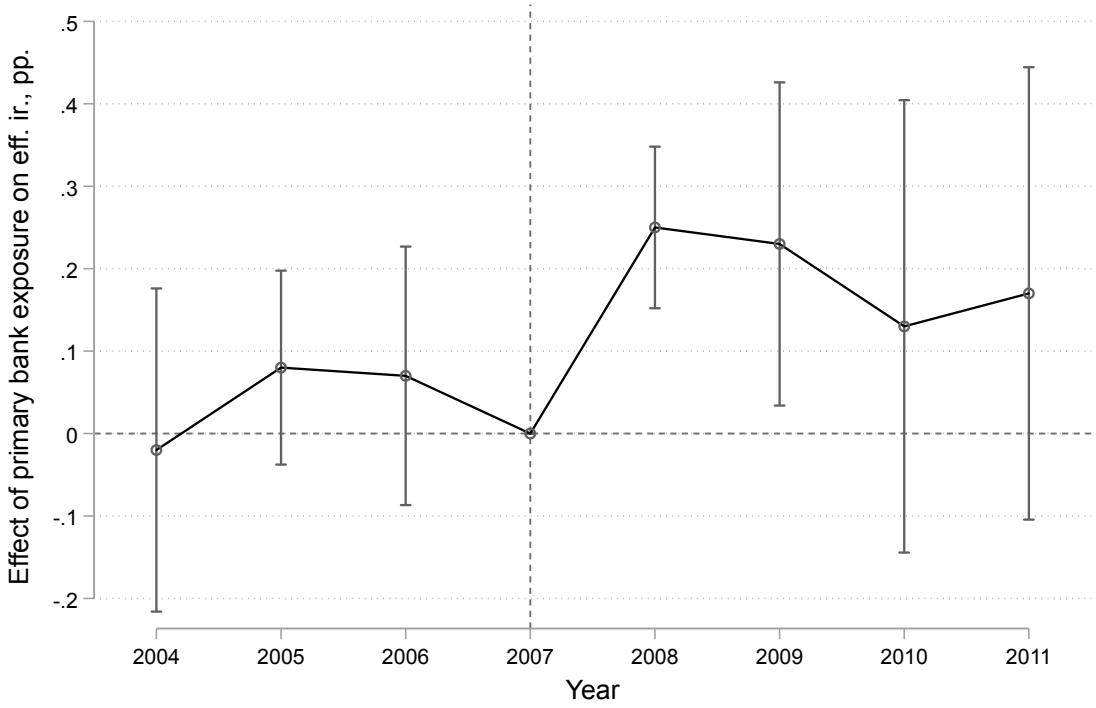
Notes: This figure plots the cumulative percentage of firms that exited the sample by each year by the exposure of their pre-crisis primary bank. The sample includes all firms in our baseline sample, as described in Section 3.1. Exposure of firms' pre-crisis primary banks is determined based on banks' outstanding loans-to-deposits ratios, as detailed in Section 3.2.

Figure 6: Differences-in-Differences Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Outstanding Loans



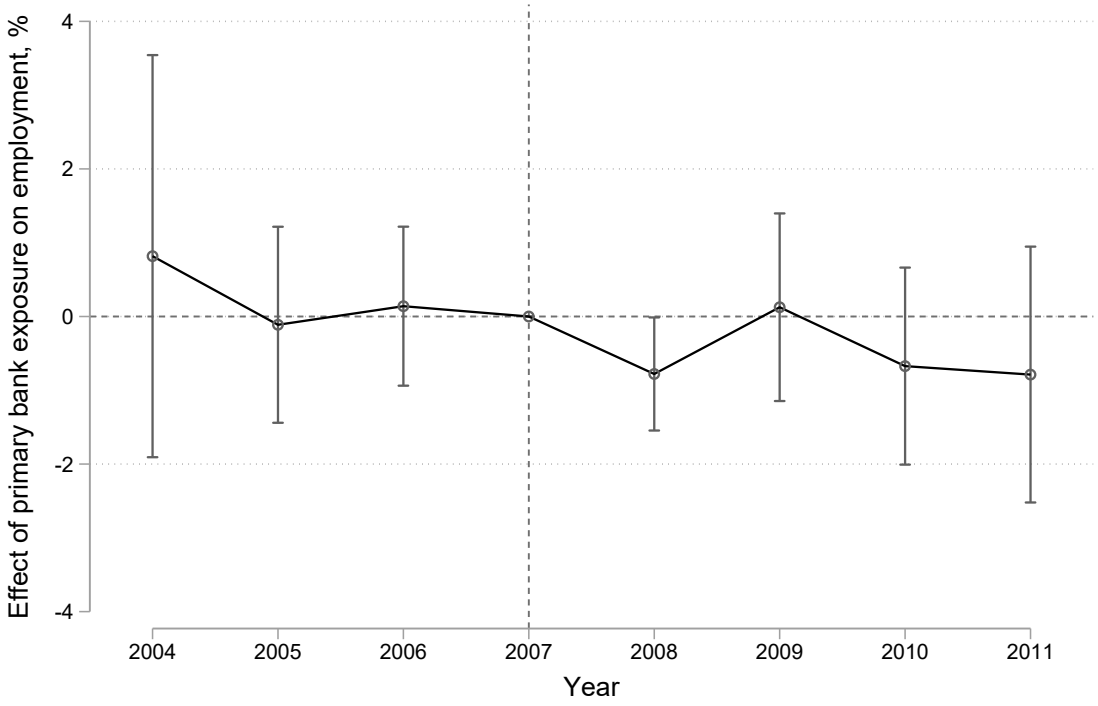
Notes: This figure plots OLS estimates of the effect of firms' pre-crisis primary bank exposure on outstanding loans using our year-by-year differences-in-differences model at the firm level. The dependent variable is the log of outstanding loans (10,000 2005 DKK) held across all banks by a firm in each year. The points plotted represent estimates of the coefficients on interaction terms between year dummies and an indicator for exposure of the firm's primary bank in 2007 (the elements of β in equation (2)). These estimates correspond to those in column 4 of Table B1 in Appendix B. A firm's primary bank is defined as exposed if it had a loans-to-deposits ratio in 2007 at or above the median firm's primary bank's, as described in detail in Section 3.2. The sample includes all firms in our baseline sample, as described in Section 3.1. Vertical bars represent 95% confidence intervals, where the standard errors have been clustered at the level of the firm's primary bank in 2007 (the level of treatment).

Figure 7: Differences-in-Differences Estimates of the Effect of Pre-Crisis Primary Bank Exposure on the Effective Interest Rate



Notes: This figure plots OLS estimates of the effect of firms' pre-crisis primary bank exposure on the effective interest rate using our year-by-year differences-in-differences model at the firm level. The dependent variable is the imputed effective interest rate paid across all bank loans by a firm in each year. The points plotted represent estimates of the coefficients on interaction terms between year dummies and an indicator for exposure of the firm's primary bank in 2007 (the elements of β in equation (2)). These estimates correspond to those in column 8 of Table B1 in Appendix B. A firm's primary bank is defined as exposed if it had a loans-to-deposits ratio in 2007 at or above the median firm's primary bank's, as described in detail in Section 3.2. The sample includes all firms in the baseline sample that were active and paid a positive effective interest rate in all years between 2004-2011. Vertical bars represent 95% confidence intervals, where the standard errors have been clustered at the level of the firm's primary bank in 2007 (the level of treatment).

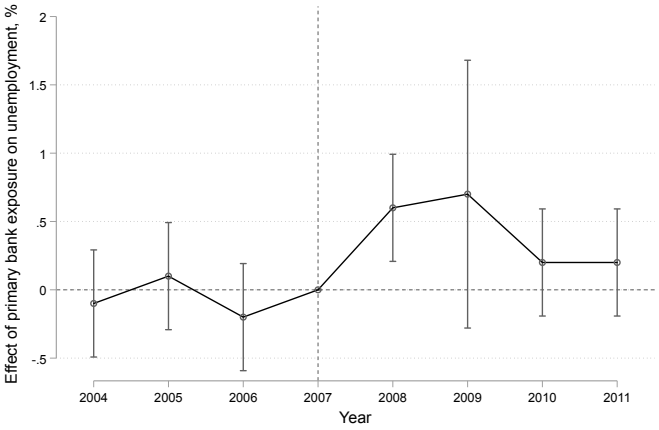
Figure 8: Differences-in-Differences Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Intensive Margin Employment



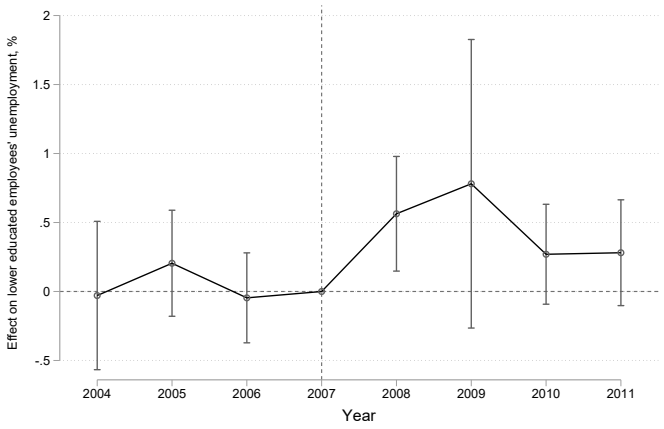
Notes: This figure plots OLS estimates of the effect of firms' pre-crisis primary bank exposure on employment using our year-by-year differences-in-differences model at the firm level. The dependent variable is the log of the number of employees at a firm in each year plus one. The points plotted represent estimates of the coefficients on interaction terms between year dummies and an indicator for exposure of the firm's primary bank in 2007 (the elements of β in equation (2)). These estimates correspond to those in column 2 of Table B4 in Appendix B. A firm's primary bank is defined as exposed if it had a loans-to-deposits ratio in 2007 at or above the median firm's primary bank's, as described in detail in Section 3.2. The sample includes all firms in our baseline sample, described in Section 3.1, that were active in all years between 2004-2011. Vertical bars represent 95% confidence intervals, where the standard errors have been clustered at the level of the firm's primary bank in 2007 (the level of treatment).

Figure 9: Effects of Pre-Crisis Primary Bank Exposure on Worker Unemployment

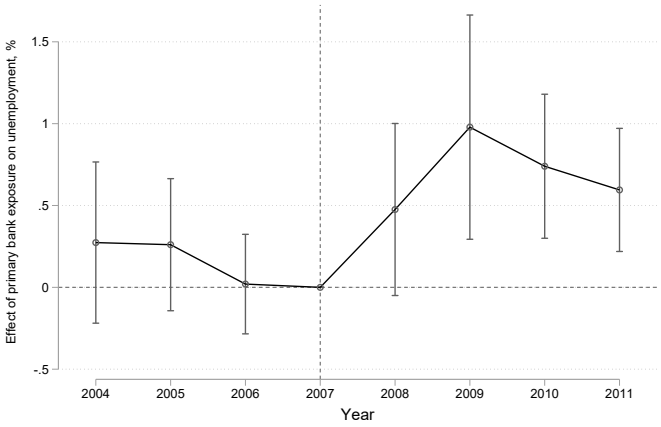
(a) Non-managerial Workers



(b) Low-educated Workers



(c) Short-tenured Workers



Notes: This figure plots OLS estimates of the effect of firms' pre-crisis primary bank exposure on employee outcomes using our year-by-year differences-in-differences model at the worker level. The full set of results underlying the panels in this figure, including effects for complementary groups of workers, are presented in B6 in Appendix B. The dependent variable in all panels is an indicator variable equal to one if the worker spent any part of the year unemployed. The points plotted represent estimates of the coefficients on interaction terms between year dummies and an indicator for exposure of the firm's primary bank in 2007 (the elements of β in equation (4)). A worker's firm's primary bank is defined as exposed if it had a loans-to-deposits ratio in 2007 at or above the median firm's primary bank's, as described in detail in Section 3.2. The baseline sample of workers includes all workers between age 35-60 employed in 2007 at firms in our baseline sample of firms. Panel (a) shows estimates of the effect for workers in non-managerial positions. Panel (b) shows estimates of the effect for low-educated workers. Low-educated workers are those employees who have at most completed a primary or secondary level education. Panel (c) shows estimates of the effect for short-tenured workers. Short-tenured workers are those workers with two or less years of tenure. Vertical bars represent 95% confidence intervals, where the standard errors have been clustered at the level of the worker's firm's primary bank in 2007 (the level of treatment).

Table 1: Pre-crisis Firm Descriptive Statistics

	All Firms	Non-exposed Primary Bank	Exposed Primary Bank	Ratio of Means	p-value
Firm Demographics					
Age (Years)	14.66	14.16	15.16	0.94	0.34
	(13.46)	(13.28)	(13.62)		
Share in Copenhagen	0.07	0.07	0.07	0.94	0.86
	(0.26)	(0.25)	(0.26)		
Share A/S	0.53	0.53	0.54	0.99	0.85
	(0.50)	(0.50)	(0.50)		
Number of Employees	36.65	35.07	38.21	0.92	0.70
	(153.69)	(149.20)	(157.99)		
Industry					
Share Manufacturing	0.22	0.21	0.24	0.87	0.36
	(0.42)	(0.41)	(0.43)		
Share Construction	0.18	0.18	0.17	1.07	0.37
	(0.38)	(0.39)	(0.38)		
Share Retail	0.44	0.45	0.43	1.06	0.12
	(0.50)	(0.50)	(0.49)		
Share ICT	0.03	0.03	0.03	0.95	0.79
	(0.17)	(0.17)	(0.17)		
Share Real Estate	0.02	0.02	0.02	0.88	0.41
	(0.15)	(0.14)	(0.15)		
Share Business Services	0.10	0.10	0.10	0.97	0.72
	(0.30)	(0.30)	(0.31)		
Financials (1,000 2005 DKK)					
Revenue	64,788	61,698	67,838	0.91	0.76
	(417,110)	(372,189)	(457,140)		
Revenue per Worker	1,671	1,761	1,583	1.11	0.17
	(4,263)	(5,237)	(3,004)		
EBITDA	9523	1,172	736	1.59	0.37
	(18,637)	(19,682)	(17,543)		
Total Assets	55,556	49,516	61,516	0.81	0.59
	(581,514)	(504,917)	(648,275)		
Bank Debt	13,990	12,471	15,489	0.81	0.51
	(100,378)	(77,855)	(118,467)		
Bank Deposits	1,674	1,502	1,843	0.82	0.51
	(15,351)	(15,730)	(14,966)		
Current Ratio	1.26	1.26	1.26	1.00	0.97
	(1.11)	(1.22)	(0.99)		
N	13,924	6,916	7,008		

Notes: This table provides descriptive statistics of firm characteristics in 2007 by exposure of firms' primary banks in 2007. The sample includes all firms in the baseline sample, as described in detail in Section 3.1. Column 1, titled 'All Firms', reports means for all firms in the sample. Standard deviations are in parentheses below. Columns 2 and 3, titled 'Non-exposed Primary Bank' and 'Exposed Primary Bank', report the same statistics for firms with non-exposed and exposed primary banks in 2007 respectively. Column 4, titled 'Ratio of Means', reports the ratio of the mean in column 2 to the mean in column 3. Column 5, titled 'p-value', reports the p-value from a two-sided t-test against the null hypothesis of equal means where standard errors have been clustered at the level of the firm's primary bank in 2007. A/S (*aktieselskaber*) firms are stock-based incorporated firms. 'ICT' stands for Information and Communications Technology. 'EBITDA' stands for Earnings before Interest, Taxes, Depreciation, and Amortization and is a widely used indicator of a firm's cash flow. The current ratio is the ratio of current liabilities to current assets and measures a firm's liquidity. Monetary values have been winsorized at the 1st and 99th percentiles.

Table 2: Within-Firm Model Estimates of the Effect of Banks' Pre-Crisis Exposure on Firms' Bank Debt

	(1) Log loans	(2) Log loans	(3) Log loans
Exposed	0.505	0.491	0.476
	(0.546)	(0.481)	(0.420)
2004 x Exposed	0.248	0.229	0.209
	(0.350)	(0.330)	(0.379)
2005 x Exposed	0.501	0.489	0.458
	(0.353)	(0.328)	(0.373)
2006 x Exposed	0.348	0.341	0.328
	(0.261)	(0.247)	(0.257)
2008 x Exposed	-0.598	-0.606	-0.633
	(0.156)	(0.150)	(0.161)
2009 x Exposed	-0.867	-0.876	-0.920
	(0.218)	(0.204)	(0.225)
2010 x Exposed	-1.242	-1.251	-1.291
	(0.358)	(0.341)	(0.426)
2011 x Exposed	-1.648	-1.647	-1.684
	(0.465)	(0.440)	(0.498)
Firm-year FE	No	No	Yes
Industry-year FE	No	Yes	No
Region-year FE	No	Yes	No
A/S Firm-year FE	No	Yes	No
N	27,206	27,206	27,206

Notes: This table presents OLS estimates of the effect of banks' pre-crisis exposure to the financial crisis on firms' outstanding loan balances using the within-firm model in equation (1). The dependent variable in all columns is the log of outstanding loans (10,000 2005 DKK) held by a firm at a bank it had a relationship with in 2007 plus one. 'Exposed' is an indicator equal to one if the bank at which the loans are held had a loans-to-deposits ratio equal to or higher than the median firm's primary bank's in 2007 (and as described in detail in Section 3.2). A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample includes all firm-bank relationships with an average loan balance of at least 2% of average total assets over the years 2004-2011 for firms active in each of those years. Standard errors appear in parentheses below the respective estimates and are clustered at the bank level (the level of treatment).

Table 3: Differences-in-Differences Estimates of the Effect of Pre-crisis Primary Bank Exposure on Bank Borrowing

	Log loans (1)	Log loans (2)	Log loans (3)	Log loans (4)	Log loans pre-crisis pr. bank (5)	Log loans pre-crisis npr. banks (6)	Log loans (7)	Effective interest rate (8)
Exposed	0.06	0.02	0.02					
	(0.16)	(0.07)	(0.06)					
Post x Exposed	-0.05	-0.06	-0.06	-0.06	-0.11	0.06	-0.03	0.21
	(0.03)	(0.02)	(0.02)	(0.02)	(0.07)	(0.10)	(0.03)	(0.07)
Covariate-year FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes*
Municipality-year FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
A/S Firm-year FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	No	Yes	Yes	Yes	Yes	Yes
Sample	Full	Full	Full	Full	Full	Full	Surviving Firms	IR
N	27,848	27,848	27,848	27,848	27,848	27,848	22,088	16,368

Notes: This table presents OLS estimates of the effect of firms' pre-crisis primary bank exposure on bank borrowing using the collapsed version of our main differences-in-differences model in equation (2). The dependent variable in columns 1-4 and 7 is the log of outstanding loans (10,000 2005 DKK) held by a firm in each year across all banks plus one. The dependent variable in column 5 is the log of outstanding loans (10,000 2005 DKK) held by a firm at its 2007 primary bank in each year plus one. The dependent variable in column 6 is the log of outstanding loans (10,000 2005 DKK) held by a firm at all other banks except for the 2007 primary bank in each year plus one. The dependent variable in column 8 is the effective interest rate paid by a firm across all loans in each year, winsorized at the 5th and 95th percentiles in each year. We describe in detail how we impute the effective interest rate in Section 4.2. 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firm's primary bank's in 2007. 'Post' is an indicator equal to one for the crisis/post-crisis years 2008-2010 and zero otherwise. Covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. The specification in column 8 does not control for the effective interest rate in 2007. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in columns 1-6 includes all firms in our baseline sample, as described in detail in Section 3.1. The sample in column 7 includes firms in the baseline sample that were active in all years between 2008-2011. The sample in column 8 (IR) includes all firms in the baseline sample that were active and paid a positive effective interest rate in all years between 2004-2011. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table 4: Differences-in-Differences Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Firm Debt

	(1) Log total debt	(2) Log total debt	(3) Log debt to suppliers
Post x Exposed	-0.01	-0.02	-0.03
	(0.03)	(0.01)	(0.01)
Covariate-year FE	Yes	Yes	Yes
Municipality-year FE	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes
A/S Firm-year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Sample	All NI	Surviving NI	Surviving NI
N	12,510	10,860	10,860

Notes: This table presents OLS estimates of the effect of firms' pre-crisis primary bank exposure on debt using the collapsed version of our main differences-in-differences model in equation (2). The dependent variable in columns 1 and 2 is the log of total debt (10,000 2005 DKK) for a firm in each year plus one. The dependent variable in column 3 is the log of debt to suppliers (10,000 2005 DKK) for a firm in each year plus one. 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firm's primary bank's in 2007. 'Post' is an indicator equal to one for the crisis/post-crisis years 2008-2010 and zero otherwise. Covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in column 1 includes all firms in our baseline sample (as described in detail in Section 3.1) for which we have non-imputed (NI) balance sheet data for each year a firm was active between 2004-2011. The sample in columns 2 and 3 includes all firms in our baseline sample for which we have non-imputed balance sheet data and were active in all years from 2008-2011. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table 5: Differences-in-Differences Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Firm Level Employment I

	(1) Log employees	(2) Log employees	(3) Log employees	(4) Log employees
Post x Exposed	-0.019	-0.007	-0.015	0.001
	(0.011)	(0.004)	(0.008)	(0.005)
Covariate-year FE	Yes	Yes	Yes	Yes
Municipality-year FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
A/S Firm-year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sample	Full	Surviving Firms	Low Liquidity Surviving Firms	High Liquidity Surviving Firms
N	27,848	22,088	11,044	11,044

Notes: This table presents OLS estimates of the effect of firms' pre-crisis primary bank exposure on employment using the collapsed version of our main differences-in-differences model in equation (2). The dependent variable in all columns is the log of employees for a firm in each year plus one. 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firm's primary bank's in 2007. 'Post' is an indicator equal to one for the crisis/post-crisis years 2008-2010 and zero otherwise. Covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in column 1 includes all firms in our baseline sample (as described in detail in Section 3.1). The sample in column 2 includes all firms in our baseline sample that remained in the sample between 2008-2011. The sample in column 3 includes firms in the baseline sample that remained in the sample from 2008-2011 with a current ratio (current assets/current liabilities) in 2007 in the bottom half of the distribution of current ratios. The sample in column 4 includes firms in the baseline sample that remained in the sample from 2008-2011 with a current ratio in 2007 in the top half of the distribution of current ratios. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table 6: Differences-in-Differences Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Firm Level Employment II

	Log managers	Log non-managers	Log low-educated employees	Log high-educated employees	Mean employee tenure
	(1)	(2)	(3)	(4)	(5)
Post x Exposed	0.003	-0.010	-0.008	0.002	-0.014
	(0.010)	(0.004)	(0.005)	(0.004)	(0.027)
Covariate-year FE	Yes	Yes	Yes	Yes	Yes
Municipality-year FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
A/S Firm-year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sample	Surviving Firms	Surviving Firms	Surviving Firms	Surviving Firms	Surviving Firms
N	22,088	22,088	22,088	22,088	22,088

Notes: This table presents OLS estimates of the effect of firms' pre-crisis primary bank exposure on employment outcomes using the collapsed version of our main differences-in-differences model in equation (2). The dependent variables in columns 1 and 2 are the log number of employees in managerial and non-managerial positions at a firm in a given year, plus one. The dependent variables in columns 3 and 4 are the log number of low-educated and high-educated employees in a year, plus one. Low-educated employees are those workers who have at most completed a primary- or secondary-level education. High-educated employees are those who have completed a tertiary-level education. The dependent variable in column 5 is the average tenure in years of a firm's employees in a year. 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firms' primary bank's in 2007. 'Post' is an indicator equal to one for the crisis/post-crisis years 2008-2010 and zero otherwise. Covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. A/S firm refers to joint-stock companies (*aktieselskaber*). The sample in all columns includes all firms in our baseline sample (as described in detail in Section 3.1) that remain in the sample from 2008-2011. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table 7: Pre-crisis Worker Descriptive Statistics

	All Workers	Non-exposed Primary Bank	Exposed Primary Bank	Ratio of Means	p-value	Short-tenured workers	Mid-tenured workers	Long-tenured workers
Age (Years)	45.99	45.81	46.14	0.99	0.00	44.91	45.78	48.13
	(7.23)	(7.21)	(7.23)					
Share Female	0.31	0.32	0.30	1.06	0.01	0.33	0.31	0.28
	(0.46)	(0.47)	(0.46)					
Share Danish Born	0.94	0.94	0.95	0.99	0.04	0.93	0.94	0.97
	(0.23)	(0.24)	(0.23)					
Years of Education	13.41	13.32	13.48	0.99	0.00	13.46	13.60	13.30
	(2.45)	(2.42)	(2.48)					
Share Tertiary Education	0.13	0.11	0.14	0.77	0.02	0.13	0.14	0.10
	(0.33)	(0.31)	(0.35)					
Share Managers	0.05	0.05	0.05	1.08	0.00	0.04	0.06	0.07
	(0.22)	(0.23)	(0.22)					
Experience (Years)	22.15	21.90	22.37	0.98	0.02	19.80	22.22	26.28
	(8.87)	(8.86)	(8.87)					
Tenure (Years)	5.74	5.52	5.93	0.93	0.12	0.71	5.12	16.11
	(6.76)	(6.55)	(6.93)					
Share New Hires	0.19	0.20	0.18	1.05	0.46	0.40	0.00	0.00
	(0.39)	(0.40)	(0.39)					
Share in First Job	0.01	0.01	0.01	1.09	0.45	0.01	0.01	0.00
	(0.08)	(0.08)	(0.07)					
N	259,441	119,498	139,943			119,221	73,280	66,940

Notes: This table provides descriptive statistics of worker characteristics in 2007 by exposure of workers' firms' primary banks in 2007. The sample includes all workers employed at firms in the baseline sample, as described in detail in Section 3.1. Column 1, titled 'All Workers', reports means for all workers in the sample. Standard deviations are in parentheses below. Columns 2 and 3, titled 'Non-exposed Primary Bank' and 'Exposed Primary Bank', report the same statistics for workers employed at firms with non-exposed and exposed primary banks in 2007, respectively. Column 4, titled 'Ratio of Means', reports the ratio of the mean in column 2 to the mean in column 3. Column 5, titled 'p-value', reports the p-value from a two-sided t-test against the null hypothesis of equal means where standard errors have been clustered at the level of the worker's firm's primary bank in 2007. Columns 6, 7, and 8 report means for short-, mid-, and long-tenured workers in 2007 respectively. Short-tenured workers are those with two years of tenure or less. Mid-tenured workers are those with between 3 and 8 years of tenure. Long-tenured workers are those with 9 or more years of tenure.

Table 8: Differences-in-Differences Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Worker Unemployment I

	Unemployment				
	(1)	(2)	(3)	(4)	(5)
Post x Exposed	0.004	0.002	0.004	0.004	0.000
	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)
Firm covariate-year FE	Yes	Yes	Yes	Yes	Yes
Worker covariate-year FE	Yes	Yes	Yes	Yes	Yes
Municipality-year FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
A/S Firm-year FE	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes
Sample	All	Managers	Non-managers	Low-educated	High-educated
N	518,882	26,720	492,162	446,906	66,296

Notes: This table presents OLS estimates of the effect of workers' firms' pre-crisis primary bank exposure on worker unemployment using the collapsed version of our main differences-in-differences model in equation (4). The dependent variable in all columns is an indicator variable equal to one if the worker spent any part of the year unemployed. 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firm's primary bank's in 2007. 'Post' is an indicator equal to one for the crisis/post-crisis years 2008-2010 and zero otherwise. Firm covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. Worker covariate-year fixed effects include an indicator for being born in Denmark and an indicator for having completed tertiary education by 2007, interacted with year dummies. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in column 1 includes all workers between age 35-60 employed at firms in our baseline sample (as described in detail in Section 3.1) in 2007. The sample in columns 2 and 3 includes all workers employed in managerial and non-managerial positions in 2007 respectively. The sample in columns 4 and 5 includes all low- and high-educated workers employed at firms in our sample in 2007 respectively. Low-educated workers are those employees who have at most completed a primary- or secondary-level education. High-educated workers are those who have completed a tertiary-level education. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table 9: Differences-in-Differences Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Worker Unemployment II

	Unemployment		
	(1)	(2)	(3)
Post x Exposed	0.005	0.001	0.001
	(0.002)	(0.003)	(0.002)
Firm covariate-year FE	Yes	Yes	Yes
Worker covariate-year FE	Yes	Yes	Yes
Municipality-year FE	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes
A/S Firm-year FE	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes
Sample	Short-tenured	Mid-tenured	Long-tenured
N	238,442	146,560	129,282

Notes: This table presents OLS estimates of the effect of workers' firms' pre-crisis primary bank exposure on worker unemployment using the collapsed version of our main differences-in-differences model in equation (4). The dependent variable in all columns is an indicator variable equal to one if the worker spent any part of the year unemployed. 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firm's primary bank's in 2007. 'Post' is an indicator equal to one for the crisis/post-crisis years 2008-2010 and zero otherwise. Firm covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. Worker covariate-year fixed effects include an indicator for being born in Denmark and an indicator for having completed tertiary education by 2007, interacted with year dummies. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in column 1 includes all workers between age 35-60 employed at firms in our baseline sample (as described in detail in Section 3.1) in 2007. The sample in columns 1, 2, and 3 includes all short-, mid-, and long-tenured workers employed at firms in our sample in 2007 respectively. Short-tenured workers are those with two years of tenure or less. Mid-tenured workers are those with between 3 and 8 years of tenure. Long-tenured workers are those with 9 or more years of tenure. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table 10: Aggregate Implications of the Shock to Credit Supply on Employment

	All 2007-2008	Low-educated 2007-2008
Change in employment at surviving firms	-38,410	-36,195
% change in employment at surviving firms	-9.1%	-10.0 %
Share of change in employment due to shock	4.2%	4.9 %

Notes: This table presents a basic summary of the total loss in employment from 2007-2008 at firms in our sample, and the share of this loss which can be explained by the reduction in credit supply following the calculations laid out in Section 5.3. Column 1 presents the calculations for total employment while column 2 presents the calculations for the employment of low-educated workers. The change in employment in row 1 represents the difference in employment between 2007 and 2008 at firms in our sample that did not exit the sample. Row 2 displays the change in employment in row 1 in percentage terms. Row 3 presents the share of the fall in employment in row 1 that can be explained by the shock to credit supply in equation (5). In arriving at this calculation we make two assumptions: 1) the total effect of the shock to credit supply on employment is the sum of the direct effects at the firm level, and 2) non-exposed banks did not shift their supply of credit. The denominator of (5) is the change in employment in row 1. The numerator is the difference between the sum of predicted employment from model (2) and counterfactual employment in 2008 for firms with an exposed pre-crisis primary bank. Counterfactual employment in 2008 for firms with an exposed pre-crisis primary bank is taken to be the predicted value of employment less the estimated effect of pre-crisis primary bank exposure.

Appendix

A Data

This appendix provides details on the dataset used in this paper and how we combined the raw sources to create it. The information given here is meant to not only increase transparency with respect to the construction of our dataset, but is also meant to act as a source of documentation in English for researchers working with Danish register data.

The dataset used in this paper combines data from three different sources: administrative registers from Statistics Denmark, account-level tax records from the Danish Tax Authority (SKAT), and bank balance sheet information that can be obtained either from the Danish Financial Supervisory Authority (*Finanstilsynet*) or the MFI Statistics from Danmarks Nationalbank. These datasets can be merged and analysed within Statistics Denmark's secure computing environment, where ID variables for banks (*cvrnr*), firms (*cvrnr*), and workers (*pnr*) are anonymised.

A.1 Administrative Data from Statistics Denmark

The dataset constructed in this paper builds off of IDA: the Integrated Database for Labor Market Research maintained and provided by Statistics Denmark. IDA contains annual cross-sections of employment information for individuals during the last week of November. In its raw form, IDA consists of the following separately stored datasets, which can be linked together using unique personal identifiers and unique firm and workplace identifiers:

- **Personal Information (IDAP):** IDAP contains the information relating to persons in IDA, including labour market experience, weeks during the past year in which the individual was unemployed, and net earnings across all jobs. The key information contained in IDAP is an individual's primary attachment to the labour market during the last week in November each year, contained in the *pstill* variable. This variable contains detailed information on an individual's labour market status and allows individuals to be identified as working, unemployed, or out of the labour force. Where applicable, individuals are assigned a secondary (*sstill*) attachment to the labour market. For instance, full-time students who also have part-time jobs, are recorded as undergoing education as their primary labour market attachment, and working as a secondary attachment.

Starting from the raw IDAP files we had access to, we cleaned the data by dropping observations with missing personal identifiers. We then constructed labour market status indicators for persons who are working, unemployed, or outside of the labour market based on the value of *pstill* and following the groupings used in the IDAP documentation provided by Statistics Denmark and available here. We then used the variables *arledgr* (for observations prior to 2008) and *ledighed_brutto* (for observations from 2008 and onwards) to construct indicators for those individuals who were unemployed or out of the labour force at some point over the last 12 months. The variables *pstill*, *sstill*, *psoc_status_kode*, and *ssoc_status_kode* were then used to generate indicators of whether an individual was recorded as being self-employed, or in a managerial position in the data.

- **Employment Information (IDAN):** IDAN contains personal and firm & workplace identifiers for all jobs held during the last week in November each year making it the key which enables a matching of employees to employers for each employment relationship in the cross-section. That is, persons with multiple jobs will appear once in IDAN for each job they hold in the last week of November, even if they have multiple jobs with the same employer. While IDAP only contains information on each individual's primary and, when given, secondary employment relationship, there is no limit as to the number of jobs an individual is recorded as holding in IDAN. IDAN also records an hourly wage for each job, and contains information indicating the quality of the hourly wage measure, which varies, particularly for part-time and new employees (see Lund and Vejlin, 2015).

  Importantly, IDAN classifies each employment relationship as one of eight different job types with the variables *TYPE* and *TYPE2008* from 2008 onwards. These job types allow for the identification of the primary job held during the last week in November each year if the individual was recorded as holding more than one job. Prior to and including 2007, employment relationships were only included in IDAN if the employee earned a total annual salary of at least 10,000 DKK. Since 2008, the requirement has been relaxed to include each employment relationship where the employee earns at least the equivalent of four hours of work at the guaranteed wage rate.

  Starting from the raw IDAN files we had access to, we cleaned the data by dropping observations with missing personal identifiers and duplicate observations. From IDAN, we are primarily interested in obtaining the measure of hourly earnings recorded for each job. For individuals who are recorded as having more than one job at the same employer, we

compute the average hourly wage across these jobs. We then collapsed the IDAN data, so that employees with multiple jobs at the same employer are recorded only once in the data. To do this we dropped observations according to the following hierarchy: when one job is a type A job, keep this one; if none are type A jobs, but one is a type H job, keep this one; if none are type A or H jobs, but one is a type B job, keep this one. If all jobs are type N jobs, randomly select one and drop the rest. Finally, we constructed variables capturing the 2007 values of a number of different variables for individuals in the data.

- **FIRE-IDA Key (FIDA):** While IDAN contains firm identifiers linking employees to the firms they were employed at, these firm identifiers are not always the same ones that are recorded in the firm accounting statistics, FIRE (more on this register below). FIDA provides these firm identifiers. In addition, FIDA provides the same information regarding labour market attachment as in IDAN.

  Starting from the raw FIDA files we had access to, we cleaned the data by dropping duplicate observations. From FIDA we would like to have a listing of jobs in which observations are unique at the *pnr-year-cvrnr* level. For employees with multiple jobs at the same employer, we keep only the observation for the primary job as indicated by *pstill* and drop the rest.

Using personal identifiers, the data in IDA/FIDA as described above, can be supplemented with data from the additional following registers maintained and provided by Statistics Denmark:

- **Population Register (BEF):** BEF contains background demographic information on the entire population of individuals registered in Denmark. For some individuals in IDAP, age is missing or improperly recorded. Thankfully, BEF contains the date of birth for each individual, allowing for an exact calculation of the age of each worker during the last week of November in each year to coincide with the data in IDA.

  In 2007 the Danish parliament enacted a large scale reform of the public sector, (*Strukturreformen*) redrawing the boundaries for many municipalities, retiring some, and establishing new ones. To deal with this, we choose to assign pre-2007 observations to their post-2007 municipalities. For the vast majority of individuals, their municipality remained unchanged by the reform. For many living in a municipality affected by the reform, we can accurately assign them to their new municipality using their registered residential addresses (which are anonymised in the data files we work with, but still usable). A small

number of observations we are unable to accurately assign them to their new municipality and are thus dropped from the data.

- **Education Register (UDDA):** UDDA contains information on the highest completed level of education for individuals in the population register. Statistics Denmark provides keys for assigning the average total number of months required to complete each qualification, and for categorising individuals into educational groups based on the highest attained qualification. These are: early childhood education, primary education, lower secondary education, upper secondary education, short-cycle tertiary education, bachelor or equivalent, master or equivalent, doctoral degree or equivalent. In most analyses, we group these categories into three broader ones: primary education (early childhood education and primary education), secondary education (lower and upper secondary education), vocational education (short-cycle tertiary education), and tertiary education (bachelor's, master's, and doctoral degrees or equivalent).

- **Income Register (IND):** IND contains highly detailed information on income at the individual level. In particular, it allows one to decompose annual total income into earnings, income generated from self-employment, income from government transfers, and a number of other sources. As a measure of individuals' income, we use the variable *loenmv_13* (total income) which includes both taxable and tax-free elements of an individual's base pay, severance pay, stock options, and sick pay.

- **Occupational Classification Module (AKM):** AKM is a register that combines information on income, education, workplace industry, social insurance membership, and employer reporting to assign individuals a labour market status and occupational classification (for the employed) with respect to their primary attachment to the labour market. Occupations are classified according to DISCO: the Danish version of the ILO's ISCO (International Standard Classification of Occupations) for the individuals' primary job in a year. From 2003 to 2008, the primary job was the job at the employer from which the individual earned the highest annual income. From 2009 onwards, the primary job is defined as the job at the employer where the individual worked the most hours.

  Starting with the raw AKM files we had access to, we cleaned the data by dropping duplicate observations and observations with missing personal identifiers. We then extract the major groups (1 digit ISCO codes) from the raw 6 digit DISCO codes and construct

variables capturing the 2007 occupational codes for individuals in the data.

- **Wage Statistics Register (LON/LONN):** The wage statistics register contains employer-reported information on employees in firms with 10 or more full-time equivalent employees. Starting in 2010, Statistics Denmark changed the concept they use to define and calculate hourly earnings. Consequently, LON files contain annual cross-sections from the wage statistics register up until 2010, while LONN files contain annual cross-sections starting in 2009, applying the new definitions. In addition to information on earnings, LON and LONN also include employer-reported information on employee pension contributions, working hours, and occupations.

  Starting with the raw LON and LONN files we had access to, we cleaned the data by dropping duplicate observations and observations with missing personal identifiers. For 2009 and 2010, we use data from LON, and from 2011 onwards, we use data from LONN. We extract the major groups (1 digit ISCO codes) from the raw 6 digit DISCO codes and construct variables capturing the 2007 occupational codes for individuals in the data. *cvrnr* only becomes available in LONN on, so to identify employers in LON (prior to 2011) we use the workplace identifier, *arbnr*. From LON and LONN we want to have a dataset that is unique at the *pnr*-*year*-employer level, so we collapse the data taking the mean earnings and total hours worked across all jobs at the same employer.; For occupations we take the occupational code from the job for which the employee is recorded as having the highest number of working hours.

- **General Firm Statistics Register (FIRM):** FIRM contains firm-level information sourced from the business statistics register (*ESR*). In particular, FIRM records entry and exit dates for Danish firms at the firm level (CVRnr-level). As FIRM does not impose restrictions based on firm size or level of activity, it contains many firms which are completely inactive or only active in a very limited sense.

  Unfortunately the data in the FIRM registry are very messy. Starting with the raw FIRM files we had access to, we first identify the year of firm entry and exit according to the information in the data. There are some firms that are recorded as entering and exiting in multiple periods; here we define a firm's entry date as the earliest recorded year of entry and the exit date as the latest recorded year of exit. Some firms remain in the registry although they have been recorded as having exited. To deal with this we redefine a firm's

exit date as the last year they were recorded in the registry if they are still observed past their recorded exit year.

- **Firm-level Accounting Statistics (FIRE):** FIRE contains detailed accounting information at the *cvrnr*-level for all active businesses in Denmark with more than 50 employees as well as some smaller businesses (see Bobbio and Bunzel, 2018). Importantly, the firm identifiers in FIRE are not always the same as those that are recorded as the firm identifiers linked to workers in IDA. FIDA provides the link to match the firms in FIRE with the employers in IDA.

- **Firm Bankruptcies (Konkurser):** This dataset contains a list of all registered bankruptcies, along with the month and year in which the bankruptcy was declared.

In preparing the dataset, we began by cleaning each register to remove duplicate entries, and remove firms or individuals with missing identifiers or key variables. We then merge the registers by proceeding in the following way:

1. **Individual Data**: BEF, IDAP, UDDA, and AKM are merged together at the pnr-year level. The pnr-year observations in IDAP make up our base population of individuals, and as such we drop all observations in BEF, UDDA, and AKM that are not found in IDAP. The merged datasets are then temporarily saved as a dataset called 'individuals.dta'.

2. **Firm Data**: FIRM and FIRE are merged at the cvrnr level. The cvrnr-year observations in FIRE make up our base population of firms, and as such we drop all observations in FIRM that are not found in FIRE. The merged datasets are then temporarily saved as 'firms.dta'.

3. **Linking Individuals and Firms**: In linking individuals to firms, we carry out the following three successive merges:

   (a) Merge 'individuals.dta' and IDAN at the pnr-year level. The resulting dataset is a complete listing of jobs in IDA with supplementary individual background characteristics. Since the variables in 'individuals.dta' are crucial covariates, we drop any observations in IDAN which are not matched to the background information in 'individuals.dta'. Since we want to track individuals though time even when they are not attached to a job in IDAN, we keep the pnr-year observations in 'individuals.dta' that

are not matched to observations in IDAN. This dataset is not unique at the pnr-year level as there are some individuals with multiple jobs in any given year.

(b) Merge the dataset generated in (a) with FIDA. For reasons known to DSt., the firm identifier for an employer in IDAN is not the same as the one in FIRE for the same firm. FIDA is the link that provides the correct identifier for each employment relationship in IDA, enabling the integration of firm balance sheet information from FIRE.

(c) Merge the dataset generated in (b) with 'firms.dta'.

Once all the administrative registers have been merged we are left with a dataset at the individual-firm-year level. At this point we use the raw data to generate a number of employment-related variables at the individual level (years of tenure, indicator for being a new hire, indicator for being displaced due to firm exit, spells of unemployment, etc.) and firm level (aggregate number of employees, number of new hires, number of separations, new hire rate, mean log gross hourly wage, etc.).

A.2 Account-Level Data

The account-level data we use stems from the URTE and IRTE registers maintained and provided by the Danish Tax Authority (SKAT). These registers are constructed using compulsory reports on all accounts that were open over the course of a year by all entities granting credit and accepting deposits. As such, URTE and IRTE contain the accounts held not only at commercial banks, but also those linked to credit cards granted at, say, the local gas station or corner store.

URTEVIRK is the extract from a register containing information on loan accounts held by firms and IRTEVIRK is the file containing firms' deposit accounts. Each file contains data at the account-firm-year level across these basic fields: account number, firm identifier, bank identifier, account balance as of the 31st of December, and the total interest paid on the account over the course of the year. We collapse the data to the firm-bank-year level by summing the account balances and interest payments made for all accounts held by the same firm at the same bank in the same year. By way of the unique firm and bank identifiers, we are able to merge this data with the merged register data described above, and the bank balance sheet data to be described below.

A.3 Bank Balance Sheet Data

We use data on banks' balance sheets collected for the MFI statistics by Danmarks Nationalbank. These same data are also made publicly available by the Danish Financial Supervisory Authority (*Finanstilsynet*) and can be accessed through their website here in English and here in Danish. Once submitted to Statistics Denmark, the bank identifiers (cvrnrs) were annonymised to match the annoymised identifiers in URTEVIRK and IRTEVIRK allowing the bank balance sheet data to be merged with the account-level data.

B Further Tables and Figures

Table B1: Difference in Difference Estimates of the Effect of Pre-crisis Primary Bank Exposure on Bank Borrowing

	Log loans (1)	Log loans (2)	Log loans (3)	Log loans (4)	Log loans pre-crisis pr. bank (5)	Log loans pre-crisis npr. banks (6)	Log loans (7)	Effective interest rate (8)
Exposed	0.04	0.01	0.01					
	(0.14)	(0.06)	(0.05)					
2004 x Exposed	0.05	0.00	-0.01	-0.02	0.02	-0.03	0.01	-0.02
	(0.09)	(0.08)	(0.07)	(0.07)	(0.15)	(0.09)	(0.08)	(0.10)
2005 x Exposed	0.04	0.01	0.00	-0.01	0.02	-0.02	0.01	0.08
	(0.07)	(0.05)	(0.04)	(0.04)	(0.13)	(0.09)	(0.05)	(0.06)
2006 x Exposed	0.04	0.01	0.00	0.00	0.01	0.01	-0.01	0.07
	(0.06)	(0.05)	(0.04)	(0.04)	(0.08)	(0.06)	(0.04)	(0.08)
2008 x Exposed	-0.06	-0.09	-0.09	-0.09	-0.12	0.07	-0.06	0.25
	(0.03)	(0.03)	(0.02)	(0.02)	(0.06)	(0.03)	(0.03)	(0.05)
2009 x Exposed	0.01	-0.01	-0.02	-0.02	-0.04	0.01	0.02	0.23
	(0.05)	(0.05)	(0.03)	(0.03)	(0.07)	(0.05)	(0.05)	(0.10)
2010 x Exposed	0.02	0.00	0.00	0.00	-0.08	0.06	0.04	0.13
	(0.07)	(0.07)	(0.05)	(0.05)	(0.08)	(0.07)	(0.07)	(0.14)
2011 x Exposed	-0.01	-0.02	-0.04	-0.04	-0.16	0.09	0.01	0.17
	(0.07)	(0.06)	(0.05)	(0.05)	(0.12)	(0.08)	(0.06)	(0.14)
Covariate-year FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes*
Municipality-year FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
A/S Firm-year FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	No	Yes	Yes	Yes	Yes	Yes
Sample	Full	Full	Full	Full	Full	Full	Surviving Firms	IR
N	107,754	107,754	107,754	107,754	107,754	107,754	80,101	54,040

Notes: This table presents OLS estimates of the effect of firms' pre-crisis primary bank exposure on bank borrowing using our main differences-in-differences model in equation (2). The dependent variable in columns 1-4 and 7 is the log of outstanding loans (10,000 2005 DKK) held by a firm in each year at across all banks plus one. The dependent variable in column 5 is the log of outstanding loans (10,000 2005 DKK) held by a firm at its 2007 primary bank in each year plus one. The dependent variable in column 6 is the log of outstanding loans (10,000 2005 DKK) held by a firm at all other banks except for the 2007 primary bank in each year plus one. The dependent variable in column 8 is the effective interest rate paid by a firm across all loans in each year, winsorized at the 5th and 95th percentiles in each year. We describe in detail how we impute the effective interest rate in Section 4.2. 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firm's primary bank's in 2007. The estimates presented for the interactions of the 'Exposed' indicator with year dummies correspond to the elements of the β vector in equation (2). Covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. The specification in column 8 does not control for the effective interest rate in 2007. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in columns 1-6 includes all firms in our baseline sample, as described in detail in Section 3.1. The sample in column 7 includes firms in the baseline sample that were active in all years between 2008-2011. The sample in column 8 (IR) includes all firms in the baseline sample that were active and paid a positive effective interest rate in all years between 2004-2011. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table B2: Difference in Difference Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Firm Debt

	(1) Log total debt	(2) Log total debt	(3) Log debt to suppliers
2004 x Exposed	-0.01	0.00	0.02
	(0.03)	(0.02)	(0.04)
2005 x Exposed	0.01	0.01	0.01
	(0.02)	(0.02)	(0.05)
2006 x Exposed	-0.02	-0.01	0.03
	(0.01)	(0.01)	(0.03)
2008 x Exposed	-0.03	-0.04	-0.02
	(0.05)	(0.01)	(0.03)
2009 x Exposed	-0.02	-0.03	-0.01
	(0.06)	(0.01)	(0.02)
2010 x Exposed	0.02	-0.01	-0.02
	(0.07)	(0.01)	(0.02)
2011 x Exposed	0.02	0.00	0.02
	(0.07)	(0.02)	(0.03)
Covariate-year FE	Yes	Yes	Yes
Municipality-year FE	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes
A/S Firm-year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Sample	All NI	Surviving NI	Surviving NI
N	37,101	30,908	30,908

Notes: This table presents OLS estimates of the effect of firms' pre-crisis primary bank exposure on debt using our main differences-in-differences model in equation (2). The dependent variable in columns 1 and 2 is the log of total debt (10,000 2005 DKK) for a firm in each year plus one. The dependent variable in column 3 is the log of debt to suppliers (10,000 2005 DKK) for a firm in each year plus one. 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firms' primary bank's in 2007. The estimates presented for the interactions of the 'Exposed' indicator with year dummies correspond to the elements of the β vector in equation (2). Covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in column 1 includes all firms in our baseline sample (as described in detail in Section 3.1) for which we have non-imputed (NI) balance sheet data in each year the firm was active between 2004-2011. The sample in columns 2 and 3 includes all firms in our baseline sample for which we have non-imputed balance sheet data and which were active in all years from 2008-2011. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table B3: Difference in Difference Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Firm Exit

	(1) Sample Exit	(2) Firm Exit
2004 x Exposed	0.004	0.003
	(0.002)	(0.001)
2005 x Exposed	0.003	0.002
	(0.001)	(0.001)
2006 x Exposed	0.00	0.00
	(0.00)	(0.00)
2008 x Exposed	0.007	-0.003
	(0.004)	(0.002)
2009 x Exposed	0.008	0.002
	(0.005)	(0.003)
2010 x Exposed	0.008	0.001
	(0.007)	(0.004)
2011 x Exposed	0.011	0.008
	(0.008)	(0.007)
Covariate-year FE	Yes	Yes
Municipality-year FE	Yes	Yes
Industry-year FE	Yes	Yes
A/S Firm-year FE	Yes	Yes
Firm FE	Yes	Yes
Sample	Full	Full
N	107,754	107,754

Notes: This table presents OLS estimates of the effect of firms' pre-crisis primary bank exposure on firm exit using our year-by-year differences-in-differences model in equation (2). The dependent variable in column 1 is an indicator variable equal to one if the firm exits the baseline sample in a particular year. A firm exits the sample when it is no longer included in the FIDA database, which can occur when firms go out of business or do not meet minimum thresholds for being considered an active business as defined by Statistics Denmark. The dependent variable in column 2 is an indicator variable equal to one if the firm is documented as having gone out of business in the register of general firm statistics (*generel firmastatistik*, FIRM). 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firm's primary bank's in 2007. The estimates presented for the interactions of the 'Exposed' indicator with year dummies correspond to the elements of the β vector in equation (2). Covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in both columns includes all firms in our baseline sample, as described in detail in Section 3.1. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table B4: Difference in Difference Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Firm Level Employment I

	(1) Log employees	(2) Log employees	(3) Log employees	(4) Log employees
2004 x Exposed	0.002	0.008	0.030	-0.006
	(0.014)	(0.014)	(0.019)	(0.011)
2005 x Exposed	-0.008	-0.001	-0.003	0.005
	(0.008)	(0.007)	(0.011)	(0.005)
2006 x Exposed	0.000	0.001	0.000	0.002
	(0.006)	(0.006)	(0.008)	(0.005)
2008 x Exposed	-0.019	-0.008	-0.018	0.002
	(0.012)	(0.004)	(0.006)	(0.004)
2009 x Exposed	-0.018	0.001	0.003	-0.001
	(0.014)	(0.006)	(0.010)	(0.007)
2010 x Exposed	-0.016	-0.007	-0.011	-0.003
	(0.017)	(0.007)	(0.010)	(0.009)
2011 x Exposed	-0.024	-0.009	-0.019	0.002
	(0.022)	(0.009)	(0.011)	(0.012)
Covariate-year FE	Yes	Yes	Yes	Yes
Municipality-year FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
A/S Firm-year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Sample	Full	Surviving Firms	Low Liquidity Surviving Firms	High Liquidity Surviving Firms
N	107,754	80,101	39,885	40,216

Notes: This table presents OLS estimates of the effect of firms' pre-crisis primary bank exposure on employment using our year-by-year differences-in-differences model in equation (2). The dependent variable in all columns is the log of employees for a firm in each year plus one. 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firms' primary bank's in 2007. The estimates presented for the interactions of the 'Exposed' indicator with year dummies correspond to the elements of the β vector in equation (2). Covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in column 1 includes all firms in our baseline sample (as described in detail in Section 3.1). The sample in column 2 includes all firms in our baseline sample which remained in the sample from 2008-2011. The sample in column 3 includes firms in the baseline sample that remained in the sample from 2008-2011 with a current ratio (current assets/current liabilities) in 2007 in the bottom half of the distribution of current ratios. The sample in column 4 includes firms in the baseline sample that remained in the sample from 2008-2011 with a current ratio in 2007 in the top half of the distribution of current ratios. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table B5: Difference in Difference Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Firm Level Employment II

	Log managers	Log non-managers	Log low-educated employees	Log high-educated employees	Mean employee tenure
	(1)	(2)	(3)	(4)	(5)
2004 x Exposed	-0.009	0.012	0.005	0.018	0.039
	(0.014)	(0.014)	(0.014)	(0.009)	(0.040)
2005 x Exposed	-0.006	0.002	-0.001	0.013	0.042
	(0.011)	(0.007)	(0.007)	(0.006)	(0.028)
2006 x Exposed	0.006	0.002	-0.001	0.015	-0.009
	(0.008)	(0.006)	(0.006)	(0.005)	(0.020)
2008 x Exposed	0.006	-0.011	-0.011	0.007	0.006
	(0.008)	(0.004)	(0.004)	(0.005)	(0.019)
2009 x Exposed	0.005	-0.001	0.000	0.013	-0.032
	(0.006)	(0.007)	(0.007)	(0.005)	(0.038)
2010 x Exposed	0.002	-0.009	-0.008	0.009	-0.012
	(0.009)	(0.008)	(0.006)	(0.007)	(0.046)
2011 x Exposed	-0.002	-0.010	-0.009	0.005	-0.070
	(0.008)	(0.009)	(0.009)	(0.010)	(0.039)
Covariate-year FE	Yes	Yes	Yes	Yes	Yes
Municipality-year FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
A/S Firm-year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Sample	Surviving Firms	Surviving Firms	Surviving Firms	Surviving Firms	Surviving Firms
N	80,101	80,101	80,101	80,101	80,101

Notes: This table presents OLS estimates of the effect of firms' pre-crisis primary bank exposure on employment outcomes using our main differences-in-differences model in equation (2). The dependent variables in columns 1 and 2 are the log number of employees in managerial and non-managerial positions at a firm in a given year, plus one. The dependent variables in columns 3 and 4 are the log number of low-educated and high-educated employees in a year plus one respectively. Low-educated employees are those workers who have at most completed a primary- or secondary-level education. High-educated employees are those workers who have completed a tertiary-level education. The dependent variable in column 5 is the average tenure in years of a firm's employees in a year. 'Exposed' is an indicator equal to one if the firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firms' primary bank's in 2007. The estimates presented for the interactions of the 'Exposed' indicator with year dummies correspond to the elements of the β vector in equation (2). Covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in all columns includes all firms in our baseline sample (as described in detail in Section 3.1) that remain in the sample from 2008-2011. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table B6: Differences-in-Differences Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Worker Unemployment I

	Unemployment				
	(1)	(2)	(3)	(4)	(5)
2004 x Exposed	-0.001	-0.005	-0.001	0.000	-0.006
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)
2005 x Exposed	0.001	-0.004	0.001	0.002	-0.005
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
2006 x Exposed	-0.001	0.001	-0.002	0.000	-0.006
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
2008 x Exposed	0.005	0.001	0.006	0.006	0.000
	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)
2009 x Exposed	0.007	0.002	0.007	0.008	-0.005
	(0.005)	(0.003)	(0.005)	(0.005)	(0.005)
2010 x Exposed	0.002	0.001	0.002	0.003	-0.006
	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)
2011 x Exposed	0.002	0.006	0.002	0.003	-0.001
	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)
Firm covariate-year FE	Yes	Yes	Yes	Yes	Yes
Worker covariate-year FE	Yes	Yes	Yes	Yes	Yes
Municipality-year FE	Yes	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes	Yes
A/S Firm-year FE	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes
Sample	All	Managers	Non-managers	Low-educated	High-educated
N	2,075,528	106,880	1,968,648	1,787,624	265,184

Notes: This table presents OLS estimates of the effect of workers' firms' pre-crisis primary bank exposure on worker unemployment using our main differences-in-differences model in equation (4). The dependent variable in all columns is an indicator variable equal to one if the worker spent any part of the year unemployed. The dependent variable in columns 5, 6, 7, and 8 is the log of total weeks unemployed in a year plus one. 'Exposed' is an indicator equal to one if a worker's firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firm's primary bank's in 2007. The estimates presented for the interactions of the 'Exposed' indicator with year dummies correspond to the elements of the β vector in equation (2). Firm covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. Worker covariate-year fixed effects include an indicator for being born in Denmark and an indicator for having completed tertiary education by 2007, interacted with year dummies. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in column 1 includes all workers between age 35-60 employed at firms in our baseline sample (as described in detail in Section 3.1) in 2007. The sample in columns 2 and 3 includes all workers employed in managerial and non-managerial positions in 2007 respectively. The sample in columns 4 and 5 includes all low- and high-educated workers employed at firms in our sample in 2007 respectively. Low-educated workers are those who have at most completed a primary- or secondary-level education. High-educated workers are those who have completed a tertiary level education. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

Table B7: Differences-in-Differences Estimates of the Effect of Pre-Crisis Primary Bank Exposure on Worker Unemployment II

	Unemployment		
	(1)	(2)	(3)
2004 x Exposed	0.003	0.000	-0.005
	(0.002)	(0.004)	(0.005)
2005 x Exposed	0.003	0.000	0.003
	(0.002)	(0.003)	(0.002)
2006 x Exposed	0.000	-0.002	-0.002
	(0.002)	(0.002)	(0.002)
2008 x Exposed	0.005	0.001	0.005
	(0.003)	(0.002)	(0.003)
2009 x Exposed	0.010	0.006	-0.001
	(0.003)	(0.005)	(0.008)
2010 x Exposed	0.007	-0.003	-0.003
	(0.002)	(0.004)	(0.005)
2011 x Exposed	0.006	-0.006	0.002
	(0.002)	(0.004)	(0.004)
Firm covariate-year FE	Yes	Yes	Yes
Worker covariate-year FE	Yes	Yes	Yes
Municipality-year FE	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes
A/S Firm-year FE	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes
Sample	Short-tenured	Mid-tenured	Long-tenured
N	953,768	586,240	535,520

Notes: This table presents OLS estimates of the effect of workers' firms' pre-crisis primary bank exposure on worker unemployment using our main differences-in-differences model in equation (4). The dependent variable in all columns is an indicator variable equal to one if the worker spent any part of the year unemployed. 'Exposed' is an indicator equal to one if a worker's firm's pre-crisis primary bank had a loans-to-deposits ratio at or above the median firm's primary bank's in 2007. The estimates presented for the interactions of the 'Exposed' indicator with year dummies correspond to the elements of the β vector in equation (2). Firm covariate-year fixed effects include indicators for decile in the 2007 distribution of revenue per worker, EBITDA, the current ratio, and the effective interest rate due across all loans interacted with year dummies. Worker covariate-year fixed effects include an indicator for being born in Denmark and an indicator for having completed tertiary education by 2007, interacted with year dummies. A/S firm refers to stock-based incorporated companies (*aktieselskaber*). The sample in columns 1, 2, and 3 includes all short-, mid-, and long-tenured workers between age 35-60 employed at firms in our baseline sample in 2007 respectively. Short-tenured workers are those workers with two years of tenure or less. Mid-tenured workers are those workers with between 3 and 8 years of tenure. Long-tenured workers are those workers with 9 or more years of tenure. Standard errors appear in parentheses below the respective estimates and are clustered at the level of the firm's pre-crisis primary bank (the level of treatment).

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