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The Consumption Effects of the 2007–2008 Financial Crisis: Evidence from Households in Denmark[†]

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Did the financial crisis in 2007–2008 spread from distressed banks to households through a contraction of the credit supply? We study this question with a dataset that contains observations on all accounts in Danish banks as well as comprehensive information about individual account holders and banks. We document that banks exposed to the financial crisis reduced their lending relative to nonexposed banks, which in turn caused a significant decrease in the borrowing and spending of their customers. The effects were persistent: borrowing remained lower through the postcrisis years and spending foregone during the crisis was not recovered. (*JEL* D12, D14, E21, E32, G01, G21)

The global banking crisis in 2007–2008 was followed by the Great Recession where corporate investment, employment, and household consumption fell sharply in virtually all developed countries. This pattern of a financial bust followed by a severe contraction of the real economy has played out numerous times over the last centuries (Reinhart and Rogoff 2009). A central question faced by economists trying to grasp the dynamics of the Great Recession is whether the crisis in the banking sector was transmitted to the real economy through a reduction in credit supply. The tightening of credit by banks in financial distress is one among several possible explanations why firms stopped investing and households slashed consumption in the aftermath of the financial crisis. Understanding the strength of this transmission mechanism is important for guiding policy responses to future crises. To the extent that tightened credit is responsible for the transmission to the real economy,

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it may be possible to contain a financial crisis by securing credit to the firms and households served by banks in distress. This paper explores how the financial crisis in 2007–2008 affected the borrowing and consumption of households through the credit supply channel. Our laboratory is Denmark where households, like in the United States and many other advanced economies, are highly levered and thus depend strongly on credit to sustain consumption.

We exploit a unique dataset from the Danish tax authorities, which contains information about the balance of all loan accounts in Danish financial institutions for the period 2003–2011, and add comprehensive information about account holders from administrative records as well as balance sheet information about banks. We can thus track the borrowing of households in each bank and assess the extent to which they reduced total borrowing or compensated with borrowing from other banks when their existing bank tightened credit. We can also estimate the effects on real estate and automobile choices as well as total spending imputed from income and wealth information (Browning and Leth-Petersen 2003).

Our empirical strategy exploits that the financial crisis in 2007–2008 affected Danish banks differentially depending on the structure of their balance sheet. While the origin of the crisis was losses on US mortgage-backed securities, it spread within the banking sector through the markets for short-term funding (Brunnermeier 2009; Shin 2009; Gorton and Metrick 2012). Danish banks generally had limited direct exposure to US mortgage-backed securities (Rangvid 2013), however, those that relied heavily on wholesale funding experienced a severe liquidity shock when funding markets froze in 2008. Hence, the financial crisis plausibly induced a differential credit supply shock to Danish households because banks with a stable funding base and relatively liquid assets were able to continue lending as before, whereas banks with an unstable funding base and relatively illiquid assets were forced to reduce their lending.

Based on these considerations, we measure a banks exposure to the financial crisis as the ratio of loans to deposits in 2007 where the numerator reflects relatively illiquid assets and the denominator reflects relatively stable funding. We provide two types of evidence that banks with more exposure reduced their supply of credit relative to banks with less exposure. First, in a simple bank-level analysis, we show that more exposure was associated with a significantly larger decrease in lending over the period 2008–2011. This finding mirrors existing studies of lending dynamics during the financial crisis (Ivashina and Scharfstein 2010; Cornett et al. 2011) and is clearly consistent with a differential tightening of the credit supply. Second, in the subsample of individuals with loan accounts in multiple banks, we conduct a conceptually similar exercise at the account-level. With credit demand shocks being fully absorbed by individual-time fixed effects, our finding that banks with more exposure reduced lending during the financial crisis relative to banks with less exposure must derive from a differential change in the credit supply (Khwaja and Mian 2008).

In the main analysis, we exploit this variation in the credit supply to identify how the financial crisis affected households through the credit supply channel. We match each individual with their primary bank in 2007 and ask whether customers in banks that were more exposed to the imminent financial crisis fared worse through the crisis and postcrisis period in terms of credit and consumption. Specifically, we compare the outcomes of customers in banks with above-median exposure ("exposed banks")

to the outcomes of customers in banks with below-median exposure ("nonexposed banks"). This difference-in-difference estimator identifies the direct effect of the credit supply shock on customers in exposed banks, but not the general equilibrium effects that are likely to be similar for customers in all banks.

The key challenge for identification is that banks' exposure to the financial crisis may conceivably correlate with the credit demand of their customers. Such a correlation could arise if exposed banks were also characterized by other imprudent business practices such as low credit standards and lax monitoring of borrowers. This could cause selection into exposed banks by inherently impatient individuals who borrowed beyond their means before the crisis and thus demanded less credit after the crisis. In this example, simply comparing the credit outcomes of customers in exposed and nonexposed banks would conflate demand and supply factors and therefore not correctly identify the credit supply channel.

We address this identification issue in various ways. First, we show that the observable characteristics of customers in exposed and nonexposed banks are virtually identical. Seemingly, the two types of banks served the same household segments on the eve of the crisis suggesting that they were exposed to the same demand shocks. Second, our model eliminates several confounding factors by including individual fixed effects as well as a comprehensive set of precrisis individual characteristics interacted with time dummies. For instance, nonparametric controls for the precrisis distribution of debt interacted with time dummies effectively control for differential credit demand shocks arising from differences in precrisis leverage (Dynan 2012). In a similar way, we eliminate credit demand shocks arising from differences in municipality, industry, income, age, education, and so on. Third, we show that precrisis trends in outcomes are parallel across individuals whose banks were exposed differently to the crisis. This strengthens the case that also unobservable individual characteristics affecting credit demand are uncorrelated with bank exposure.

The first set of results provides strong evidence that the financial crisis reduced household borrowing through the credit supply channel. The total debt of customers in exposed banks decreased by around DKK 12,000 (US$2,000) relative to customers in nonexposed banks over the period 2008–2009 and this difference persisted through the period 2010–2011. The drop in total debt reflects a large decrease in credit from the precrisis primary bank and a smaller increase in credit from other banks, which implies that around half of the decrease in lending by exposed banks was neutralized by their customers borrowing more in other banks.

The relative decrease in the quantity of credit to customers in exposed banks was accompanied by a relative increase in the price of credit. In a sample of newly issued consumer loans where we can infer that loan terms are comparable, we document a differential increase in the effective interest rate of around 0.75 percentage points in 2008–2009. The finding that price and quantity moved in opposite directions is consistent with a shift in supply, but not with a shift in demand.

We also present evidence suggesting that the tightening of credit imposed effective borrowing constraints on some households. Most employees in Denmark have a tax favored pension savings account funded by mandatory employer contributions, however, a steep penalty for liquidation makes this an undesirable source of liquidity for individuals with access to credit. We show that the propensity to liquidate pension accounts increased significantly for customers in exposed banks relative

to customers in nonexposed banks during the crisis. Although the absolute number of liquidations remained modest, the result is suggestive that customers in exposed banks were more likely to experience severe borrowing constraints.

The second set of results shows that the decrease in borrowing was accompanied by a significant decrease in consumption. The annual spending of customers in exposed banks decreased by almost DKK 8,500 (US$1,400) relative to customers in nonexposed banks between 2007 and 2009. Part of this effect reflects a decrease in spending on real estate: customers in exposed banks bought smaller and less expensive houses relative to customers in nonexposed banks. But other consumption margins adjusted too: customers in exposed banks became less likely to be car owners and less likely to own multiple cars relative to customers in nonexposed banks.

Since spending decisions in different time periods are tied together by the intertemporal budget constraint, we should expect a relatively low level of spending during the crisis to be matched by a relatively high level of spending in later years. We find that customers in exposed banks returned to the spending path of customers in nonexposed banks in the postcrisis years 2010–2011; however, we find no evidence that they recovered any of the spending foregone during the crisis. This may reflect that the credit supply of exposed banks remained low after the crisis or, alternatively, that consumption did not adjust flexibly to a normalization of the credit supply. Concretely, to the extent that households acquired less expensive homes and cars during the crisis because of a low credit supply, habit and transaction costs may have prevented them from adjusting these consumption margins as the credit supply normalized.

The final set of results suggests that the effects of the credit supply shock were heterogeneous across customers in exposed banks with those holding less liquidity at the eve of the crisis being more adversely affected. While the differential decrease in total debt after 2007 was large and persistent within the bottom quintile of precrisis liquidity, it was small and temporary within the top quintile. Consistent with these results, we find a negative effect on spending within the bottom quintile of liquidity in every year of the crisis and postcrisis period, but no clear evidence that spending within the top quintile was affected at all.

While our empirical results are difficult to reconcile with theoretical models of frictionless banking markets, they are consistent with different types of frictions: a cost of switching banks on the customer-side (Klemperer 1987), which makes some individuals stay with their existing bank even when they could have obtained better credit outcomes in other banks, and imperfect information on the bank-side, which creates ex ante uncertainty about default probabilities (Sharpe 1990) and deters banks from lending to new customers. Both frictions imply that customers in exposed banks on average obtain less credit than they would have as customers in nonexposed banks.

In practice, it is improbable that imperfect information plays a major role in the Danish market for consumer loans: households have relatively simple balance sheets and banks have access to comprehensive information about the income and credit histories of potential customers. It seems more likely that the relevant friction is on the customer-side, which is consistent with recent evidence that households make costly mistakes in loan markets. For instance, it has been shown in the US context that shopping from too few mortgage brokers costs the average borrower

around $1,000 (Woodward and Hall 2012) and that the frequently observed failure to refinance mortgage loans entails costs of around $11,500 in present value terms (Keys, Pope, and Pope 2016).

The main contribution of the paper is to enhance our understanding of the sharp decrease in household consumption that often follows a financial crisis. Existing studies emphasize the role of excessive leverage (Mian and Sufi 2010), falling house prices (Mian, Rao, and Sufi 2013), and increased uncertainty (Alan, Crossley, and Low 2012), whereas our analysis points to a complementary channel through the contracted credit supply of distressed banks.

The existing literature linking financial crises to household outcomes through the credit supply channel is small and has produced mixed results. Two papers show that banks with high exposure to the 2007–2008 financial crisis reduced their lending to households in its aftermath (Ramcharan, Verani, and Van den Heuvel 2016; Puri, Rocholl, and Steffen 2011). While these findings suggest that the credit supply channel contributed to the drop in consumer demand for housing and automobiles after the financial crisis, the papers only consider bank-level outcomes and therefore cannot determine whether customers in exposed banks were able to compensate with borrowing from other sources and thus ultimately maintain their desired level of consumption. One paper addresses this issue by combining bank and household survey data from Canada and concludes that the financial crisis had no effect on household consumption through the credit supply channel (Damar, Gropp, and Mordel 2014).[1]

While our measure of spending is not directly comparable to the notion of private consumption in national accounts, the estimated effect on spending suggests that credit supply was a quantitatively important factor in the collapse of household consumption after the financial crisis. To illustrate, the estimates imply that being a customer in a bank exposed to the crisis in 2007 lowered spending at the sample mean by more than 4 percent in 2009. Embedded in a general equilibrium framework, our micro estimates could help in quantifying how financial shocks shape macroeconomic outcomes.

The paper proceeds in the following way. Section I provides background information on the banking sector and the financial crisis in Denmark. Section II describes the data sources and reports summary statistics. Section III documents the differential credit supply shock. Section IV discusses the empirical strategy. Sections V–VII present the results concerning financial outcomes, consumption outcomes, and heterogeneous effects, respectively. Section VIII concludes.

I. Background

A. *The Danish Financial Sector*

The Danish financial sector counts more than 100 retail banks, however, the bank market is relatively concentrated: 4 systemically important banks account for

[1] The credit supply channel is more thoroughly documented in the context of firms. A number of papers demonstrate that firms' borrowing decreases when their bank relation is in distress (Khwaja and Mian 2008; Jiménez et al. 2014), and point to real effects in terms of reduced investment (Klein, Peek, and Rosengren 2002; Dwenger, Fossen, and Simmler 2015) and employment (Chodorow-Reich 2014; Bentolila et al. 2015).

the majority of all lending while the remaining banks are predominantly regional or local.

All banks in Denmark rely on information from both public and private sources to assess credit risk. First, there is an automated procedure for banks to obtain financial information about loan applicants directly from the tax authorities. With the consent of the applicants, banks can access data on income and debt from tax returns as well as information on arrears to the public sector. Second, banks universally acquire information on arrears to private creditors from commercial registers and credit scores, similar to FICO scores in the United States, are readily available from credit bureaus.

Based on the availability of hard information about loan applicants, it seems unlikely that informational barriers to bank switches should be larger in Denmark than in other developed countries. This is consistent with survey evidence that customer mobility in Denmark, while low in absolute terms, is high by international standards: 3.6 percent of Danish survey respondents formed a new primary bank relation in 2013 compared to 3.6 percent in the United States, 2.5 percent in Germany, 2.4 percent in the United Kingdom, and only 1 percent in the Netherlands (Bain & Company 2013).

The most distinctive feature of the Danish financial sector is the important role played by specialized mortgage credit institutions. These institutions are much more regulated than retail banks. They are only allowed to lend with collateral in Danish real estate and the loan-asset ratio on their loans cannot exceed 80 percent at origination. Moreover, they must be fully funded with publicly traded bonds and are required to lend at the interest rate at which they borrow plus a fixed premium covering average credit risk.

While consumer and auto loans are typically granted by banks and never involve mortgage credit institutions, most real estate purchases are financed with credit from both sources: a senior loan from a mortgage credit institution up to the regulatory limit and a junior loan from a bank that finances the residual. This implies that banks are typically the *marginal* providers of mortgage credit to households and that the credit limit set by banks determines the total amount of mortgage credit available to their customers. We therefore focus on the role of banks' credit supply in shaping credit and consumption outcomes of households.

B. *The 2007–2008 Financial Crisis and Its Aftermath*

In the years before the global financial crisis in 2007–2008, the Danish economy was growing at a rapid pace, the real estate market was booming, and banks expanded their lending substantially. Since lending grew much faster than deposits, some banks relied increasingly on international credit markets to finance their expansion, often through loans at short maturities (IMF 2014). While Danish banks generally had very limited exposure to the US mortgage-backed securities that triggered the financial crisis, some banks reached dangerously low levels of liquidity when global markets for wholesale funding froze (Rangvid 2013; Shin 2009). Between May and September 2008, the central bank therefore intervened several times to provide liquidity to the banking system and in October 2008, shortly after the collapse of Lehman Brothers, the government was compelled to extend a two-year

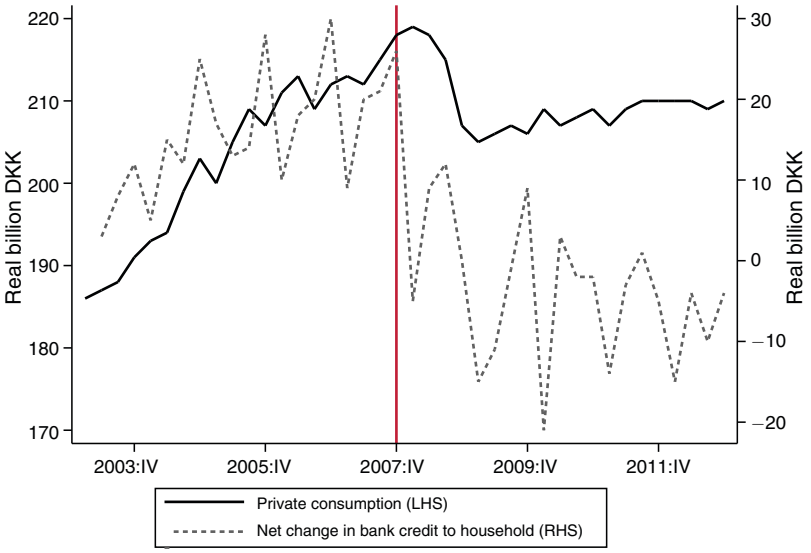

Figure 1. Aggregate Consumption and Bank Credit

Note: Figure 1 shows the evolution of private consumption and the change in bank credit to households in Denmark over the period 2003:I–2012:IV in real 2010-DKK billion.

Sources: MFI statistics from Danmarks Nationalbank and national accounts from Statistics Denmark

unlimited guarantee to all bank liabilities. Despite the massive efforts to sustain the financial sector, many banks were in serious distress: 15 banks were closed by the regulatory authorities between 2008 and 2011 and many others accepted mergers to avoid failure reducing the total number of licensed banks from 147 in 2007 to 113 in 2011 (Rangvid 2013).

A severe crisis in the real economy accompanied and aggravated the banking crisis. Between 2007 and 2009, real private consumption decreased by around 4 percent, real GDP by around 5 percent, real investment by around 18 percent, real housing prices by around 20 percent, and stock prices by more than 40 percent.

Figure 1 tracks our two key outcomes, household borrowing and consumption, over the boom and bust.[2] It shows a rapid increase in both outcomes until the peak of the financial crisis in 2008 when the expansion of credit suddenly came to a halt and consumption dropped sharply. The timing is suggestive of a causal relationship: the credit expansion stopped in the first quarter of 2008 and consumption started falling a few quarters later. The goal of the paper is to investigate whether the decline in credit and consumption can be explained with a decrease in banks' credit supply.

[2]The analysis is conducted on the basis of the MFI statistics published by the Danish Central Bank, which excludes the smallest banks; hence, the number of banks is lower than the total number of licensed banks reported above. The excluded banks, however, account for less than 1 percent of total bank lending.

II. Data

A. *Data Sources*

The main data innovation of this paper is to establish a link between individuals and their bank relations from tax records. At the end of each year, financial institutions in Denmark report the balance of their customers deposit and loan accounts to the tax authorities. The reports are compulsory and reliable since they are used for tax enforcement. We thus have a complete mapping of all loans and deposits with domestic financial institutions held by all individuals in Denmark.[3]

To the raw administrative records of the Danish tax authorities, we add comprehensive information about the individual account holders from a number of other administrative registers. This includes demographic information such as age, gender, education, home municipality, and identity of children and parents; labor market information such as wage income, industry, and unemployment spells; income and wealth information such as capital income, social transfers, value of stock portfolios, and pension accounts; auto register information such as the weight and production year of each registered automobile; real estate register information such as the size and value of each registered property. We also add detailed balance sheet information about the reporting banks obtained from the Danish Central Bank.

In the resulting dataset, we thus observe the following information for all individuals resident in Denmark for the period 2003–2011: the balance of each of their loan and deposit accounts; balance sheet information about the bank in which the account is held; and comprehensive background information about individual account holders from government registers.

B. *Imputed Spending*

One of our key outcomes is spending, which we impute from income and wealth variables. The main idea is that spending in a given period, by definition, equals disposable income minus the increase in net wealth. Hence, to the extent that disposable income and wealth can be measured precisely, it is possible to impute spending as[4]

$$(1) \qquad spending_{it} = disposable\ income_{it} - (net\ wealth_{it} - net\ wealth_{it-1}).$$

While several papers validate the imputed measure of spending by showing that it correlates strongly with survey measures of consumption (Browning and Leth-Petersen 2003; Kreiner, Lassen, and Leth-Petersen 2015), the imputation method also has limitations. Most importantly, an increase in stock prices tends to lower measured spending by creating an increase in net wealth that is not matched by

[3] In practice, we obtain the link between individuals and banks in the following way. The first four digits of the bank account numbers that we observe in the tax records uniquely identify the branch of the bank where the accounts are held in a given year. We then hand-collect lists of branch identification numbers and the corresponding banks from publications by Nets, a payment solutions provider, for each of the years 2003–2011. This establishes the dynamic link between individual account numbers and bank identity.

[4] The precise definitions of disposable income and net wealth are stated in online Appendix Table A1.

an increase in disposable income (unless the capital gain is realized). Similarly, an increase in the market interest rate reduces the market value of fixed-rate mortgage loans, which increases net wealth and lowers measured spending. In both cases, the imputation method confounds changes in valuation of balance sheet components with true savings. By contrast, refinancing of mortgage loans, whereby one loan is replaced by another with the same market value, does not affect measured spending.

We address these measurement problems in the following ways. For stock owners, we use the evolution of the general stock market index to estimate the change in portfolio values that is induced by price changes and add it back into imputed spending. With this procedure, stock price changes do not lead to mismeasurement of spending for individuals who hold the market portfolio, but will cause it to be overestimated (underestimated) for individuals whose stock portfolio underperforms (overperforms) relative to the market portfolio. Additionally, we conduct robustness tests where all stock owners are excluded; in this sample there is clearly no valuation effect of stock prices on measured spending. Similarly, in other robustness tests, we exclude all owners of real estate; in this sample there is no valuation effect of market interest rates because borrowing for other purposes than real estate takes the form of variable-rate loans whose market value is independent of market interest rates.

It is natural to compare our imputed measure of spending to the measure of private consumption employed in national accounts. The main difference between the two measures is the way they treat owner-occupied housing. Our spending measure includes expenses related to purchases and renovation of real estate. Technically, this is achieved by omitting real estate from net wealth in the imputation of spending: when households purchase real estate or incur expenses related to renovation, this concept of net wealth decreases by the full amount of the expense, through a decrease in financial assets if financed with own funds or an increase in liabilities if financed with debt, and imputed spending increases correspondingly.[5] By contrast, national accounts define consumption of owner-occupied housing as the imputed market rent and ignore any cash spending.

Despite this conceptual difference, the two measures are empirically very similar when aggregated to the population-level. As shown in Figure 2, imputed spending grew slightly faster than private consumption before the financial crisis and dropped slightly more after, but both the level of the two measures and their trend over time are quite alike.[6]

[5] A measure of non-real estate spending could, in principle, be obtained by including the market value of real estate in net wealth. In our dataset, we observe the assessed value of real estate for tax purposes, which is lower than the market value by a margin that varies over time and across regions. Simply including the assessed value of real estate in net wealth therefore yields a spending measure that is difficult to interpret because it includes some but not all real estate spending.

[6] The fact that aggregate spending fluctuated more than aggregate consumption over this period can at least partly be attributed to its cash-based treatment of real estate. According to national accounts, real estate investment surged by almost DKK 35 billion from 2004 to 2007 and then dropped by more than DKK 40 billion until 2009 while the imputed market rent of owner-occupied housing was much less volatile, increasing by less than DKK 20 billion from 2004 to 2007 and then increasing by an additional 15 billion until 2009.

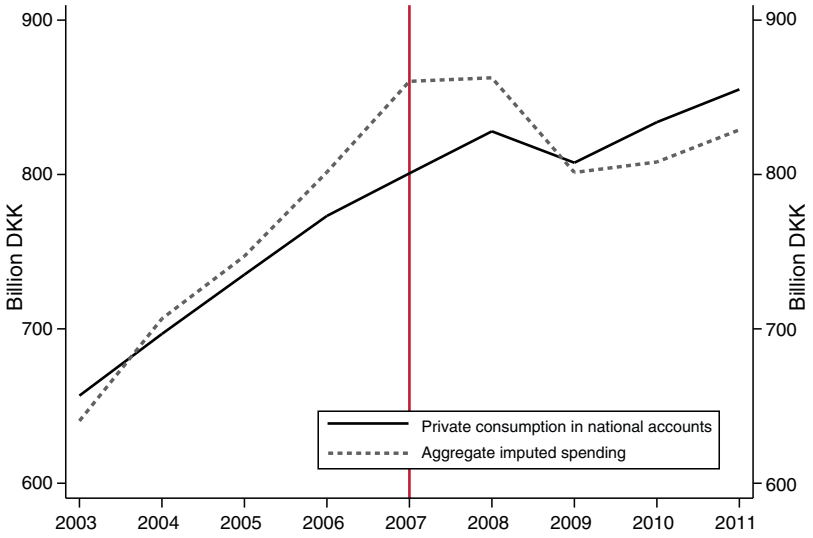

FIGURE 2. PRIVATE CONSUMPTION AND IMPUTED SPENDING

Note: Figure 2 shows the evolution of private consumption from national accounts and imputed spending aggregated to the population level over the period 2003–2011 in current DKK billion.

Sources: MFI statistics from Danmarks Nationalbank and national accounts from Statistics Denmark

C. *Sample and Summary Statistics*

Before conducting the empirical analysis, we restrict the sample in several ways. First, we remove self-employed individuals since it is generally not possible to separate borrowing for business and private purposes on the balance sheet of those operating a firm in their own name. Second, we restrict the sample to individuals between 20 and 50 years (in 2007), which is the time in the life cycle where credit plays the most important role in supporting spending. Third, we exclude individuals whose primary bank in 2007 failed during the period 2008–2011; since failed banks were typically absorbed by sound banks and all customer accounts were transferred in the process, such individuals received a fundamentally different treatment than customers in exposed but surviving banks. Finally, we study a 25 percent random sample of the resulting population for computational tractability. These restrictions leave us with a baseline sample of around 440,000 individuals, almost 3.5 million individual-years, and more than 5.7 million individual-account-years.

Once the dataset is constructed, we define a unique primary bank for each individual in 2007 using the following procedure:[7] For individuals who only had one bank relation in 2007, this is their primary bank. For individuals who had multiple bank relations in 2007, but only had a loan in one of those banks, this is their primary bank. For individuals who had loans in multiple banks in 2007, the bank in which the loan balance was largest is their primary bank. For individuals who had no loans, but had deposits in multiple banks in 2007, the bank in which the deposit

[7] To be precise, the primary bank is always a bank and not a mortgage institution.

Table 1—Summary Statistics, 2007

	All	Exposed	Nonexposed	Difference in means	Ratio of means	*p*-value
Age	35.56	35.37	35.75	−0.38	0.99	0.11
	(8.13)	(8.20)	(8.20)			
Education, short	0.27	0.28	0.27	0.00	1.01	0.91
	(0.45)	(0.45)	(0.45)			
Education, medium	0.36	0.37	0.35	0.01	1.03	0.62
	(0.48)	(0.48)	(0.48)			
Education, long	0.24	0.23	0.24	0.00	0.99	0.91
	(0.42)	(0.42)	(0.42)			
Female	0.5	0.5	0.5	0.00	1.01	0.17
	(0.50)	(0.50)	(0.50)			
Partner	0.64	0.64	0.64	0.00	1.00	0.97
	(0.48)	(0.48)	(0.48)			
Student	0.03	0.03	0.03	0.00	1.09	0.33
	(0.18)	(0.18)	(0.18)			
Kids	0.57	0.57	0.58	−0.01	0.98	0.65
	(0.50)	(0.50)	(0.50)			
Number of cars	0.46	0.47	0.45	0.02	1.04	0.57
	(0.50)	(0.50)	(0.50)			
Disposable income (DKK)	191,526	190,667	192,413	−1,746	0.99	0.74
	(83,151)	(81,541)	(81,541)			
Total income (DKK)	255,637	256,002	255,260	742	1.00	0.95
	(167,779)	(163,964)	(163,964)			
Unemployment (per mile)	30.63	29.22	32.08	−2.86	0.91	0.43
	(106.35)	(103.13)	(103.13)			
Total debt (DKK)	508,839	505,113	512,688	−7,575	0.99	0.86
	(585,181)	(578,078)	(578,078)			
Bank debt (DKK)	140,312	140,929	139,675	1,254	1.01	0.84
	(196,634)	(196,294)	(196,294)			
Bank deposits (DKK)	68,187	68,982	67,366	1,617	1.02	0.57
	(158,580)	(158,198)	(158,198)			
Imputed spending (DKK)	217,640	216,385	218,936	−2,552	0.99	0.8
	(267,829)	(269,203)	(269,203)			
Observations	434,647	220,855	213,792			

Notes: Table 1 reports means and standard deviations of personal characteristics in 2007 for all individuals (column 1), and individuals whose primary bank in 2007 had a loan-to-deposit ratio above the median (column 2), and below the median (column 3) respectively; the difference between the means in the two subsamples (column 4); the ratio of the two means (column 5) and the *p*-value of a test of identical means (column 6). All variables measured in DKK are winsorized at the first and ninety-ninth percentiles.

balance was largest is their primary bank. The procedure thus rests on the assumptions that loans provide a stronger bank relation than deposits and that bank relations are stronger the larger the account balance.

Next, we order individuals according to the loan-deposits ratio of their primary bank in 2007 and split the sample at the median individual so that the number of individuals with exposed and nonexposed banks is approximately the same.[8]

Table 1 reports precrisis summary statistics on the main variables used in the analysis for customers in banks with high and low ratios of loans to deposits separately.

[8]The small discrepancy is due to the fact that the individuals right below and right above the median who are customers in the same bank are assigned to the same group.

All variables measured in DKK are winsorized at the first and ninety-ninth percentiles to reduce the influence of extreme observations. The first column provides a sense of the demographic characteristics and financial situation of the individuals in our sample. Individuals were roughly equally distributed across the four education categories, around two-thirds had a cohabitating partner, and more than half had children. The average total income was around DKK 250,000 (US$40,000) and the average disposable income after taxes and interest payments around DKK 200,000. Since the average imputed spending was around DKK 220,000, we can infer that the average individual reduced net wealth by around DKK 20,000 in 2007. The average level of debt was around DKK 500,000 (US$80,000) implying a ratio of debt to income around 2, which is very high by international standards and higher than in, for instance, the United States.

The next columns serve to assess whether customers in exposed and nonexposed were different with respect to their precrisis observed characteristics and, hence, whether it is likely that divergence between the two groups in the crisis and postcrisis period was driven by differential credit demand shocks. This does not seem to be the case. Table 1 shows that customers in banks with high and low loan-deposit ratios were strikingly similar. None of the differences between variable means in the two samples are close to statistical significance. Hence, there are no signs of customer selection into exposed banks based on observable household characteristics.

Finally, the table illustrates the important role of specialized mortgage credit institutions: around one-third of household loans in Denmark are from banks while the remaining two-thirds are from mortgage credit institutions. Although our empirical strategy only exploits variation in the credit supply of banks, the significance of nonbank debt points to total debt as the main financial outcome of interest. Given the institutional framework explained in Section IA, we expect loans from banks and mortgage credit institutions to be complements: since bank customers typically cannot increase the share of financing from mortgage credit institutions in response to a tightening of bank credit, they are likely to purchase less real estate, which reduces borrowing from both banks and mortgage credit institutions in absolute terms.

III. The Differential Credit Supply Shock

The main premise of our analysis is that banks with fewer deposits on the liability side of their balance sheet and more loans on the asset side, tightened their credit supply more in response to the financial crisis. This section provides two types of evidence, based on bank-level and account-level data, respectively, in support of this premise.

A. *Bank-Level Analysis*

Figure 3 compares the trend in lending through the financial crisis for banks with a ratio of loans to deposits above and below the sample median in 2007. While the two groups of banks exhibited very similar growth rates in lending during the period 2005–2007, there was a sharp divergence over the period 2008–2012: whereas banks with a low loan-deposit ratio continued to expand lending, banks with a high

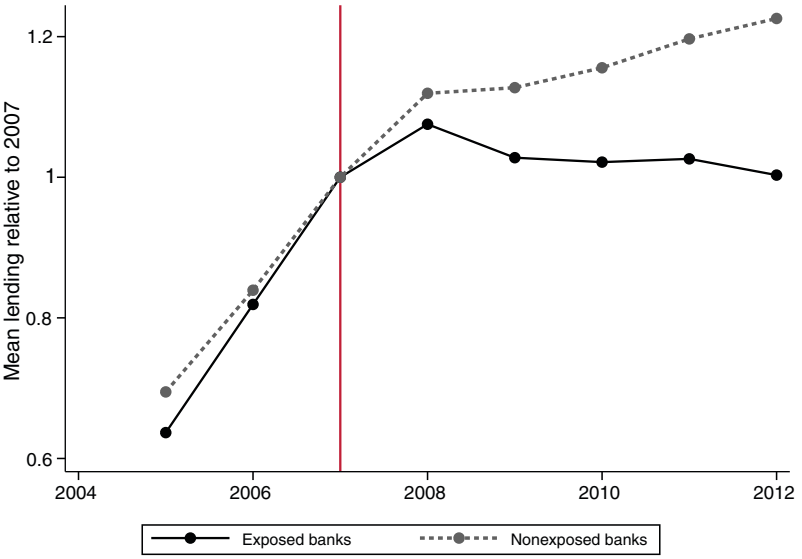

Figure 3. Bank Lending and Exposure to the Financial Crisis

Notes: Figure 3 shows lending relative to 2007 by banks with a ratio of loans to deposits ratio in 2007 above the median (exposed banks) and below (nonexposed banks). The sample includes all banks covered by the MFI statistics of the Danish Central Bank (excludes the smallest banks), which had positive lending in all years 2005–2012: a total of 89 banks. The outcome is winsorized at the fifth and ninety-fifth percentile to eliminate the influence of mergers and acquisitions.

Source: MFI statistics from Danmarks Nationalbank

loan-deposit ratio reduced lending considerably in a sudden reversal of the trend in the previous years. Table 2 shows that the negative correlation between banks' pre-crisis loan-deposit ratio and subsequent growth in lending is statistically significant, regardless of whether the regressions are unweighted or weighted with bank size and whether the loan-deposit ratio is used as a continuous variable or transformed into a dummy variable indicating a loan-deposit ratio above the median. These results are in line with existing studies of bank lending during the financial crisis (Ivashina and Scharfstein 2010; Cornett et al. 2011).[9]

B. *Loan-Level Analysis*

While the bank-level results are consistent with a differential credit supply shock, it cannot a priori be excluded that they are in fact driven by differential credit demand shocks; strictly speaking it could be customers' demand for credit that for one reason or the other correlated with banks' loan-deposit ratios rather than banks' supply of credit.

To cleanly establish the existence of a differential credit supply shock, we conduct an account-level analysis exploiting that individuals with loan accounts in multiple

[9] Online Appendix Figure A2 shows how the mean loan-deposit ratio evolved over the sample period for banks with a loan-deposit ratio above and below the median in 2007: the difference between the two means was roughly constant until 2008 and then slowly converged as banks with a high initial loan-deposit ratio reduced this ratio.

TABLE 2—BANK LEVEL ANALYSIS

	Bank lending growth, 2007–2011			
	Unweighted		Weighted	
	(1)	(2)	(3)	(4)
Exposed (dummy)	−0.1764		−0.3484	
	(0.0559)		(0.1384)	
Exposure (continuous)		−0.1907		−0.5215
		(0.0684)		(0.0771)
Constant	0.1579	0.2708	0.2026	0.5546
	(0.0393)	(0.0771)	(0.1369)	(0.1038)
Observations	89	89	89	89
R^2	0.1029	0.0821	0.0679	0.3446

Notes: Table reports estimates from bank-level regressions where the dependent variable is the change in the log of lending over the period 2007–2011 and the explanatory variable captures exposure to the financial crisis. In columns 1 and 3, the explanatory variable is a dummy indicating that the ratio of loans to deposits was above the median at the end of 2007. In columns 2 and 4, the explanatory variable is the ratio of loans to deposits at the end of 2007. In columns 1–2, the regressions are unweighted ordinary least squares whereas in columns 3–4, the regressions are weighted by total lending in 2007. The dependent variable is winsorized at the fifth and ninety-fifth percentile to eliminate the influence of mergers and acquisitions. The sample includes all banks covered by the MFI statistics of the Danish Central Bank (excludes the smallest banks), which had positive lending in all years 2005–2012: a total of 89 banks.

Source: MFI statistics from Danmarks Nationalbank

banks create within-individual variation in loan outcomes. Intuitively, if individuals with loan accounts in both exposed and nonexposed banks systematically became less likely to obtain new credit in exposed banks than in nonexposed banks after the financial crisis, this cannot be explained with changes in credit demand but must reflect a differential change in credit supply. Formally, we estimate the following account-level model:

$$newloan_{ibt} = \theta_{it} + \phi\Omega_t \times exposed_b + \gamma exposed_b + \mu. \tag{2}$$

The dependent variable $newloan_{ibt}$ indicates if individual i increased borrowing in bank b at time t; θ_{it} represents individual-time fixed effects; Ω_t is a vector of time dummies (where 2007 is omitted); and $exposed_b$ indicates if bank b had a loan-deposit ratio above the median in 2007. The model includes no covariates since individual characteristics are fully absorbed by the individual-time fixed effects. Standard errors are clustered at the bank-level.

The parameter of interest ϕ, measures how much more likely it is that a new loan is taken out in an exposed bank than in nonexposed banks when borrowers have loan accounts in both (measured relative to 2007). Since individual-year fixed effects absorb the credit demand of each individual at each point in time, any differential change in the likelihood of taking out new loans across banks with different exposure can be attributed to differential changes in the credit supply. This is an application of the within-estimator proposed by Khwaja and Mian (2008).

Figure 4 illustrates the results by plotting the estimated coefficients on the interactions between *exposed* and the year dummies (i.e., the elements in the vector ϕ). The coefficients for the years 2004–2006 are very close to zero, which implies

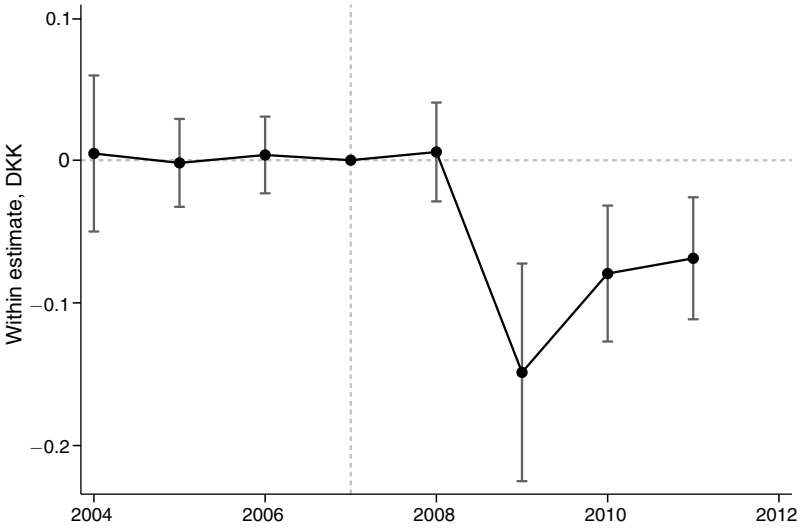

Figure 4. Bank Debt, within Estimate

Notes: Figure 4 illustrates the results from the account-level model with individual-time fixed effects where the dependent variable is a dummy indicating an increase in the loan balance relative to the previous year. The black dots represent the estimated coefficients on the interaction terms between time dummies and a dummy for banks that were exposed to the financial crisis. The gray bars represent 95 percent confidence intervals of the point estimates based on standard errors clustered at the bank-level. Precise point estimates and standard errors are reported in Table A4 in the online Appendix.

that, in the sample of individuals with loan accounts in both exposed and nonexposed banks, the likelihood of increasing the loan balance in the former relative to the latter was constant throughout the precrisis period. The coefficient for 2009 is statistically significant and the point estimate implies that individuals who increased the balance of any loan account, were 15 percentage points less likely to do so in an exposed bank than in a nonexposed bank. For 2010 and 2011, the point estimates are also significantly negative but slightly smaller. Overall, this suggests that the credit supply of banks exposed to the financial crisis decreased sharply relative to nonexposed banks in 2009 and remained lower throughout the postcrisis period.

While the analysis in this section provides clean evidence of a differential credit supply shock, the findings do not imply that customers in exposed banks were adversely affected; neither the bank-level nor the account-level results exclude that the differential credit supply shock was neutralized by customers switching from exposed to nonexposed banks. For this reason, our main analysis studies outcomes at the individual level. This allows us to capture the full effect of the differential credit supply shock on bank customers while taking into account substitution toward other sources of credit.

IV. Empirical Strategy

The main aim of the empirical analysis is to estimate the effect of banks' credit supply on the credit and consumption outcomes of households. Our empirical

strategy is to compare individuals, whose primary bank was exposed to the financial crisis and therefore reduced its credit supply, to individuals whose primary bank was less exposed. We implement this comparison with the following baseline model:

$$(3) \qquad outcome_{it} = \alpha_i + \gamma\Omega_t + \beta\Omega_t \times exposed_i + \delta\Omega_t \times X_i + \epsilon_{it},$$

where $outcome_{it}$ is a financial or consumption outcome of individual i at time t; α_i represents individual fixed effects; Ω_t is a vector of time dummies (2007 is the omitted category); $exposed_i$ is a dummy variable indicating if the primary bank of individual i in 2007 had a loan-deposit ratio above the population median; and X_i is a vector of characteristics of individual i in 2007.

The vector β contains the main coefficients of interest. For each year it measures the average change in the outcome variable relative to 2007 for individuals who were customers in exposed banks in 2007 over and above the average change over the same period for individuals who were customers in nonexposed banks. The baseline model thus yields difference-in-difference estimates of how the financial crisis affected households through the credit supply channel for each of the years 2008–2011.

For expositional simplicity, we sometimes employ a compact version of the model where outcomes are averaged within the periods 2005–2007 ("precrisis"), 2009 ("crisis"), and 2010–2011 ("postcrisis"); 2008 is partly precrisis and partly crisis and therefore omitted. With the dataset collapsed to only three time periods, the difference-in-difference estimates are expressed by the interaction terms $exposed \times crisis$ and $exposed \times postcrisis$. Whenever we employ the compact model, we always report the results from the full baseline model in online Appendix Table A2.

The main methodological challenge is the possibility that credit demand shocks correlate with the credit supply shock. For instance, it may be that customers in exposed banks incidentally had educational backgrounds, lived in geographical regions, or worked in industries that made them more affected by the crisis through other channels. Alternatively, they may have had different unobserved characteristics, such as risk attitudes or time preferences, which made them behave differently during the crisis. In either case, the credit demand shocks of individuals may have varied systematically with the exposure of their bank, which invalidates identification of the credit supply channel based on a simple comparison of customers in exposed and nonexposed banks. We address this identification issue in two ways.

First, the difference-in-difference estimates are conditional on a comprehensive set of controls. For each control variable, we include the value in 2007 as well as its interactions with year dummies. With this procedure we effectively identify the effect from a comparison of individuals with the same observed characteristics in 2007, of which some were customers in exposed banks and others were customers in nonexposed banks. The baseline model includes 161 covariates (all interacted with a full set of time dummies) that capture the following characteristics: gender (dummy for being a woman), age (dummies for each one-year age group), education (dummies for short, medium, and long education with no education as the omitted category), home ownership (dummy for owning real estate), children (dummy for having children), civil status (dummy for cohabitation with partner),

student (dummy for being a student), unemployment (dummy for unemployment spells during 2006–2007), bank debt (dummies for the deciles of the bank debt distribution in 2007), income (dummies for the deciles of the income distribution in 2007), home municipality (dummy for each of 98 Danish municipalities), and industry (dummy for each of 9 occupation sectors).

Second, β allows us to assess directly whether customers in exposed and nonexposed banks followed similar trajectories in terms of borrowing and consumption over the period 2003–2007 conditional on observed characteristics. To the extent that trends in outcomes are parallel during a period where there were no major differential shocks to credit supply, it is plausible that the unobserved characteristics shaping credit demand are roughly balanced across customers in the two types of banks.

It is important to bear in mind when interpreting the results that β measures the "partial equilibrium" effects of the credit supply shock in the sense that any general equilibrium effects are absorbed by the time dummies. For instance, to the extent that the credit supply shock induced customers in exposed banks to reduce spending and this, in turn, aggravated the economic crisis with adverse consequences for all households in the economy, these indirect effects would be included in γ and not in β. Relatedly, even banks with a low loan-deposit ratio may have tightened their credit supply because of the financial crisis, although to a lesser extent than banks with a high loan-deposit ratio, and this part of the credit supply channel is not included in β since the latter is identified from a comparison of customers in banks with a high and a low loan-deposit ratio. It should also be noted that we are effectively studying the dynamic responses to an initial impulse. Exposed and nonexposed banks had very different loan-deposit ratios before the crisis, but gradually became more similar as exposed banks reduced their lending. By contrast, customers in exposed and nonexposed banks were initially very similar, but gradually became more different as customers in exposed banks accumulated less debt and postponed desired spending.

While the baseline specifications use a dichotomous measure of bank exposure to the financial crisis, our results are generally very similar when we replace *exposed* with the loan-deposit ratio and thus use the variation in exposure within the groups of exposed and nonexposed banks. The core results with this specification are reported in online Appendix Table A3.

Finally, we note that all point estimates are reported with standard errors clustered at the level of the primary bank in 2007. This conservative clustering strategy widens the standard errors considerably given that the baseline sample includes close to 3.5 million observations at the individual-year level, but only just over 100 banks.

V. Financial Outcomes

We first use the baseline model with individual fixed effects and a full set of controls to study the main financial outcome: total debt. Figure 5 plots the estimated coefficients on the interaction terms between the year dummies and the dummy variable indicating that the individual's primary bank in 2007 was exposed to the financial crisis (i.e., the elements in the vector β).

For 2004–2006, the point estimates are almost precisely zero suggesting that the average total debt of customers in exposed and nonexposed banks grew at almost

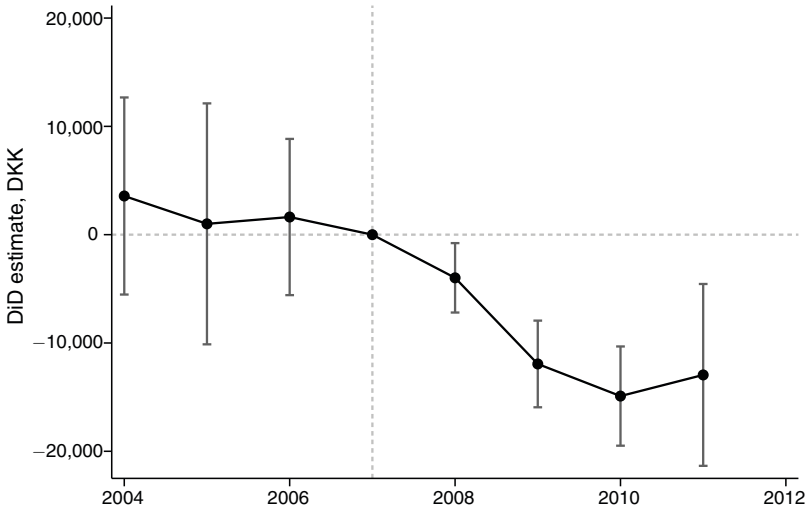

FIGURE 5. TOTAL DEBT, DIFFERENCE-IN-DIFFERENCE ESTIMATE (*DKK*)

Notes: Figure 5 illustrates the results from the baseline model where the dependent variable is total debt. The black dots represent the estimated coefficients on the interaction terms between time dummies and a dummy for individuals whose primary bank in 2007 was exposed to the financial crisis. The gray bars represent 95 percent confidence intervals of the point estimates based on standard errors clustered at the level of the primary bank in 2007. The model includes individual characteristics, industry dummies, and municipality dummies, all measured in 2007 and interacted with a full set of time dummies, as well as individual fixed effects. Precise point estimates and standard errors are reported in Table A4 in the online Appendix.

exactly the same speed before the financial crisis. For 2008–2011, the point estimates are below zero suggesting that the total debt of customers in exposed banks decreased relative to the total debt of customers in nonexposed banks after the financial crisis. Since debt is observed at the end of each year, the gradually decreasing point estimates of around DKK −4,000 for 2008, DKK −12,000 for 2009, and DKK −15,000 for 2010 imply that most of the divergence occurred in the course of 2009. All point estimates are statistically and economically significant: the difference-in-difference estimate for 2009 corresponds to around 2.4 percent of the average level of debt in 2007.

To study how the large set of controls shapes the results, we estimate the compact model while moving sequentially from a specification with no controls, which is essentially a raw comparison of average levels, to the specification with all controls. Column 1 in Table 3 implies that the average total debt was DKK 7,600 higher for customers in exposed banks than for customers in nonexposed banks in the precrisis years whereas it was DKK 6,100 lower at the peak of the crisis in 2009 (a difference-in-difference estimate of DKK −13,700) and DKK 9,900 lower after the crisis in 2010–2011 (a difference-in-difference estimate of DKK −17,500). To this most parsimonious specification, column 2 adds individual covariates; column 3 further adds municipality dummies and industry dummies, and column 4 finally adds individual fixed effects. In all specifications, the difference-in-difference estimate is virtually the same, but precision increases considerably as controls are introduced.

We then present similar results for various bank debt outcomes. As shown in column 5, customers in exposed banks decreased their total bank debt by around

Table 3—Borrowing (*DKK*)

	Total debt				Debt in banks			Total debt
					All banks	2007-primary	Other banks	Renters
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exposed	7,611	6,632	−2,009					
	(38,324)	(9,657)	(6,512)					
Crisis × exposed	−13,665	−11,336	−12,021	−12,238	−6,375	−11,430	4,883	−5,344
	(7,686)	(3,247)	(4,025)	(3,631)	(2,067)	(4,188)	(2,358)	(1,993)
Post-crisis × exposed	−17,542	−14,645	−14,320	−14,366	−7,526	−14,821	7,065	−6,810
	(9,781)	(5,678)	(5,947)	(5,474)	(2,574)	(6,182)	(3,844)	(2,007)
Fixed effects								
Covariates-time	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality-time	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Industry-time	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Individual	No	No	No	Yes	Yes	Yes	Yes	Yes
Observations	1,300,723	1,300,723	1,300,723	1,300,723	1,310,071	1,308,688	1,310,071	481,375
R^2	0.013	0.477	0.492	0.138	0.051	0.022	0.068	0.095

Notes: Table reports estimates from the compact baseline model with the following outcomes: total debt (columns 1–4 and 8), bank debt (column 5), debt in 2007 primary bank (column 6), and debt in other banks than the 2007 primary bank (column 7). Outcomes are averaged within the time periods 2005–2007 (precrisis), 2009 (crisis), and 2010–2011 (postcrisis) and winsorized at the first and ninety-ninth percentile in each period. Exposed indicates that the loans-to-deposits ratio of the individual's primary bank in 2007 was above the sample median. Covariates include categorical controls, all measured in 2007, for age, educational level, gender, home ownership, partner, unemployment spells during past 24 months, deciles of bank debt, deciles of income. Municipality fixed effects are indicators for each of the 98 municipalities and industry fixed effects indicators for 9 occupational industries. The regressions use the full sample (columns 1–7) and the subsample who did not own real estate at any time during the period 2003–2011 (column 8). Standard errors are clustered at the level of the primary bank in 2007 and are reported in parentheses. R^2 refers to within R^2 in columns with individual fixed effects.

DKK 7,500 relative to customers in nonexposed banks through the crisis with almost the entire decrease occurring before the end of 2009. The estimated effects for bank debt are smaller than for total debt in absolute terms, which confirms our expectation that loans from banks and mortgage institutes are complements: a reduction in bank debt induced by tightened bank credit spills over on nonbank debt. Measured relative to the sample mean, however, the estimated effect on bank debt is around 5 percent or more than twice as large as the effect on total debt.

Further, as shown in columns 6–7, the decrease in total bank debt can be decomposed into a decrease in debt at the bank that served as primary bank in 2007 of around DKK 14,800 and an increase in debt at other banks of around DKK 7,100. This suggests that customers in exposed banks neutralized roughly half of the differential credit supply by switching to other banks.

A comparison of columns 4 and 5 shows that almost half of the decrease in total debt occurred in mortgage institutes. This implies that real estate debt accounts for a large part of the total effect and ultimately raises the question whether there was any effect on consumer debt. Since we cannot isolate consumer debt in our dataset, we apply the baseline model to a subsample of individuals whose entire debt must be consumer debt: "renters" who did not own real estate at any point during the sample period. As shown in column 8, the estimated effect in this subsample is comparable to the estimated effect on bank debt in the full sample shown in column 5. This documents that consumer debt was also significantly affected by the credit supply shock.

While it is consistent with a static and partial equilibrium model of the credit market that a reduction in the supply causes a decrease in the equilibrium quantity, the same model also predicts an increase in the equilibrium price. In the next step of the analysis, we thus investigate whether interest rates changed differentially for customers in exposed and nonexposed banks through the crisis.

Since our dataset does not contain explicit information about loan terms, we compute the effective interest rate in the following way:

$$\text{(4)} \qquad \textit{interest rate}_t = \frac{\textit{interest paid}_t}{0.5(\textit{loan balance}_{t-1} + \textit{loan balance}_t)}.$$

The main source of error is that we only observe loan balances at the end of each year and therefore need to approximate the average loan balance in year t with the average of the loan balances at the end of year $t-1$ and year t. This implicitly assumes that loan balances evolve linearly over the year.

To meaningfully compare interest rates across loans, it is crucial to account for other loan terms, for instance whether the loan is secured with collateral and whether the rate is variable or fixed. We therefore focus the analysis on a relatively small sample of newly issued loans where we can infer that other loan terms than the interest rate are comparable. Specifically, we include an individual in period t in the estimation sample if three conditions are met: (i) total borrowing is below DKK 1.000 in period $t-1$; (ii) total borrowing is above DKK 50.000 in period t; (iii) the borrower owns no house and no car in period t. Since these borrowers did not own a house or a car at the time the loans were issued, the loans are likely to be unsecured consumer loans, which generally have variable interest rates and short maturities.

We validate the procedure by showing that the distribution of estimated interest rates is sensible (online Appendix Figure A2) and that the average effective interest rate follows the trend of the monetary policy rate closely over time (online Appendix Figure A3). We then apply the baseline model to the effective interest rate with the modification that individual fixed effects are not included so as not to restrict identification to the very small number of individuals who took out multiple loans satisfying the requirements listed above during the sample period. As shown in Figure 6, the interest rates faced by customers in exposed and nonexposed followed a very similar trend through the precrisis period, but then diverged sharply in 2009 with customers in exposed banks experiencing a relative increase in interest rates of around 0.75 percentage points.

Having established that the differential credit supply shock induced by the financial crisis affected credit outcomes in the household sector, we study a number of related financial outcomes in Table 4. First, when access to credit is constrained, households may respond by running down financial assets to mitigate the effect on consumption (Damar, Gropp, and Mordel 2014). As shown in column 1–2, customers in exposed banks reduced the value of their bank deposits and stock portfolios only slightly relative to customers in nonexposed banks through the crisis: the combined decrease of DKK 1,200 is very modest relative to the corresponding decrease in debt of DKK 14,400 (Table 3, column 4) and not statistically significant. However, as shown in column 3, the small average effect on liquidity conceals that

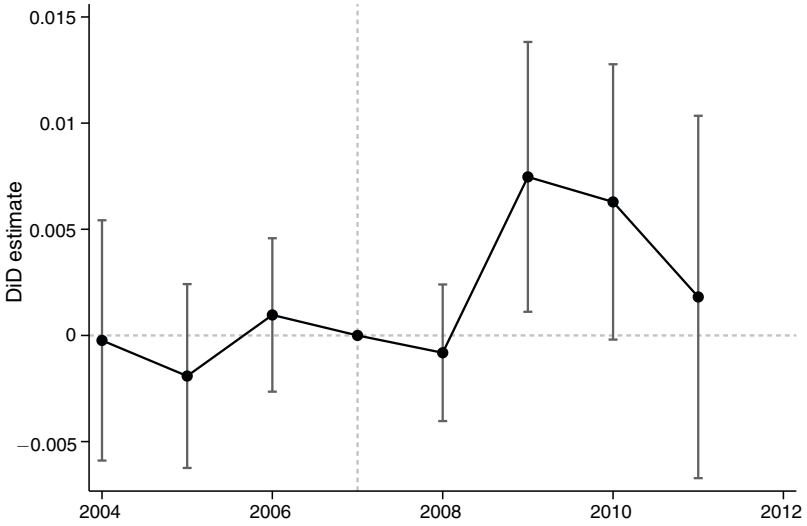

Figure 6. Effective Interest Rate, Difference-in-Difference Estimate (*Percentage Points*)

Notes: Figure 6 illustrates the results from the baseline model where the dependent variable is the effective interest rate as defined in the main text. The black dots represent the estimated coefficients on the interaction terms between time dummies and a dummy for individuals whose primary bank in 2007 was exposed to the financial crisis. The gray bars represent 95 percent confidence intervals of the point estimates based on standard errors clustered at the level of the primary bank in 2007. The model includes individual characteristics, industry dummies, and municipality dummies, all measured in 2007 and interacted with a full set of time dummies. Precise point estimates and standard errors are reported in Table A4 in the online Appendix.

Table 4—Liquidity, Borrowing Constraints, and Labor Market Outcomes

	Liquidity			Borrowing constraints	Labor market outcomes	
	Bank account (DKK) (1)	Shares (DKK) (2)	Low liquidity (dummy) (3)	Pension withdrawals (dummy) (4)	Income (DKK) (5)	Unemployment (percent) (6)
Crisis × exposed	−966.4	121.5	0.00753	0.00162	−146.3	−0.0653
	(1,620)	(792.7)	(0.00253)	(0.000854)	(411.9)	(0.0509)
Postcrisis × exposed	−1,104	−104.1	0.00916	0.00118	−657.3	−0.0975
	(2,067)	(946.9)	(0.00316)	(0.000631)	(865.5)	(0.0655)
Fixed effects						
Covariates-time	Yes	Yes	Yes	Yes	Yes	Yes
Municipality-time	Yes	Yes	Yes	Yes	Yes	Yes
Industry-time	Yes	Yes	Yes	Yes	Yes	Yes
Individual	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,310,071	1,310,071	1,310,071	1,310,071	1,300,723	1,286,969
R^2 (within)	0.029	0.010	0.005	0.008	0.335	0.113

Notes: Table reports estimates from the compact baseline model with the following outcomes: liquidity on bank accounts (column 1), market value of shares (column 2), an indicator of liquid assets below the twenty-fifth percentile (column 3), an indicator of withdrawals from tax favored pension accounts (column 4), disposable income (column 5), and unemployment (column 6). Outcomes are averaged within the time periods 2005–2007 (precrisis), 2009 (crisis), and 2010–2011 (postcrisis), and winsorized at the first and ninety-ninth percentile in each period. Exposed indicates that the loans-to-deposits ratio of the individual's primary bank in 2007 was above the sample median. Covariates include categorical controls, all measured in 2007, for age, educational level, gender, home ownership, partner, unemployment spells during past 24 months, deciles of bank debt, deciles of income. Municipality fixed effects are indicators for each of the 98 municipalities and industry fixed effects indicators for 9 occupational industries. The regressions use the full sample. Standard errors are clustered at the level of the primary bank in 2007 and are reported in parentheses.

customers in exposed banks became more likely to reach low levels of liquidity: the probability of having liquidity below the twenty-fifth percentile increased by almost 1 percentage point during the crisis for customers in exposed banks relative to customers in nonexposed banks and the difference persisted through the postcrisis period.[10]

The finding that exposed banks reduced their credit supply and that their customers were unable to compensate fully with credit from other sources suggest that customers in exposed banks were more likely to become borrowing constrained. We study this proposition using withdrawals from tax favored pension savings accounts as an indicator of borrowing constraints. While such accounts are funded by mandatory employer contributions and thus available to most individuals in Denmark, a 60 percent penalty applying to liquidations before pension age makes it a very costly source of liquidity, which we expect households to use only when alternative sources of liquidity are exhausted.[11] Column 4 documents a relative increase of 0.16 percentage points in the propensity of customers in exposed banks to withdraw funds from tax favored pension savings accounts during the crisis falling slightly to 0.12 percentage points after the crisis. The former difference-in-difference estimate corresponds to around 5 percent at the sample mean and the latter around 4 percent. While the effect on average liquidity is bound to be small because of the low number of individuals who make withdrawals, the finding is suggestive that the weakening of banks after the financial crisis imposed relatively severe borrowing constraints on some households.

Finally, we investigate whether the credit supply shock induced households to adjust their labor supply. The evidence is weak. Column 5 shows that the income of customers in exposed banks decreased by around DKK 150 between 2007 and 2009 relative to customers in nonexposed banks whereas column 6 documents a differential drop in unemployment of around 0.07 percentage points over the same period. The point estimates are consistent with the notion that households with lower access to credit were more willing to stay employed, even at lower wages, however, the results are far from statistical significance.

VI. Consumption Outcomes

We start the analysis of consumption outcomes by applying the full baseline model to our imputed measure of spending. As shown in Figure 7, the estimated coefficients on the key interactions between *exposed* and the time dummies are small for the years 2004–2006 suggesting that the spending of customers in exposed and nonexposed banks evolved similarly before the financial crisis. Coinciding with the crisis, however, there was a significant differential decrease in the spending of customers in exposed banks. Specifically, from 2007 to 2008, their spending fell by around DKK 4,500 relative to customers in nonexposed banks, and from 2008 to 2009 by an additional DKK 4,500. The difference-in-difference estimate for 2009

[10] The twenty-fifth percentile of the liquidity distribution is around DKK 5,000 depending on the specific year and this, in turn, corresponds to around 25 percent of average monthly income.

[11] This is confirmed empirically by a strong correlation between ex ante liquidity and withdrawals: almost 6 percent of individuals in the bottom decile of liquidity made withdrawals in 2009 compared to only 3 percent in the bottom decile (see online Appendix Figure A4).

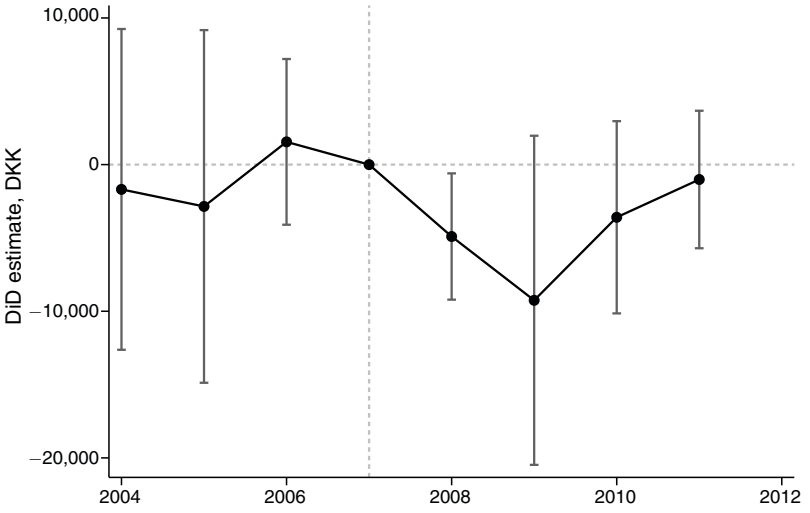

Figure 7. Imputed Spending, Difference-in-Difference Estimate (*DKK*)

Notes: Figure 7 illustrates the results from the baseline model where the dependent variable is imputed spending. The black dots represent the estimated coefficients on the interaction terms between time dummies and a dummy for individuals whose primary bank in 2007 was exposed to the financial crisis. The gray bars represent 95 percent confidence intervals of the point estimates based on standard errors clustered at the level of the primary bank in 2007. The model includes individual characteristics, industry dummies, and municipality dummies, all measured in 2007 and interacted with a full set of time dummies, as well as individual fixed effects. Precise point estimates and standard errors are reported in Table A4 in the online Appendix.

corresponds to around 4 percent of the average level of spending in 2007. After the crisis, the spending of customers in exposed banks gradually returned to the path of customers in nonexposed banks; however, there is no evidence that they recovered any of the spending that was foregone during the crisis.

When comparing the results for spending and debt, it is important to bear in mind that the former is a flow whereas the latter is a stock. Households are able to have a higher level of spending in periods where their debt increases; hence, the results showing a temporary effect on the *level of spending* in 2008–2009 are consistent with the previous results showing a temporary effect on the *growth of debt* in the same period.

We proceed by addressing the concern that differential trends in imputed spending could potentially be driven by measurement error related to stock market gains and losses (explained in Section IIIB). As shown in Table 5, the results are almost identical when estimated with the full sample (column 1) and a subsample that excludes stock owners (column 2). This suggests that measurement error in spending does not vary systematically with bank exposure. In both samples, we find that customers in exposed banks reduced spending by around DKK 8,500 during the crisis relative to customers in nonexposed banks without recovering the foregone spending in the postcrisis period.

To ascertain whether the credit supply contraction by banks exposed to the crisis only affected spending on real estate or also had an impact on consumer spending, we apply the compact baseline model to the subsample of "renters": individuals who did not own real estate at any time during the sample period. As shown in

TABLE 5—CONSUMPTION

	Imputed spending			IV estimates		Cars	
	Incl stock-owners (DKK) (1)	Excl stock-owners (DKK) (2)	Renters (DKK) (3)	Δ total debt (1st stage) (4)	Δ cumm. spending (2nd stage) (5)	Owns at least one car (dummy) (6)	Owns multiple cars (dummy) (7)
Crisis × exposed	−8,766	−8,568	−2,230			−0.00307	−0.00142
	(3,168)	(2,945)	(862.9)			(0.000832)	(0.000559)
Postcrisis × exposed	−1,548	−1,213	−1,027			−0.00277	−0.00158
	(1,954)	(1,539)	(865.5)			(0.000903)	(0.000743)
Exposed				−11,577			
				(2,724)			
Δ debt (instrumented)					0.984		
					(0.406)		
Fixed effects							
Covariates-time	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality-time	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-time	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual	Yes	Yes	Yes	No	No	Yes	Yes
Observations	1,300,723	1,009,729	481,375	355,641	355,641	1,310,071	1,310,071
R^2	0.060	0.065	0.072	0.030		0.018	0.012

Notes: Table reports estimates from the compact baseline model with individual-level outcomes: imputed spending (columns 1–3), an indicator of owning a car (column 6), an indicator of owning more than one car (column 7). These outcomes are averaged within the time periods 2005–2007 (precrisis), 2009 (crisis), and 2010–2011 (postcrisis) and winsorized at the first and ninety-ninth percentile in each time period. Table 5 also reports estimates from an instrumental variables estimation: in the first-stage, the outcome is the change in total debt between end-of 2007 and end-of 2011 (column 4) and in the second stage the outcome is the change in imputed spending between 2006–2007 and 2008–2009 (column 5). Exposed indicates that the loans-to-deposits ratio of the individual's primary bank in 2007 was above the sample median. Covariates include categorical controls, all measured in 2007, for age, educational level, gender, home ownership, partner, unemployment spells during past 24 months, deciles of bank debt, deciles of income. Municipality fixed effects are indicators for each of the 98 municipalities and industry fixed effects indicators for 9 occupational industries. The regressions use the full sample (columns 1–2 and 4–7) and the subsample who did not own real estate at any time during the period 2003–2011 (column 3). Standard errors are clustered at the level of the primary bank in 2007 and are reported in parentheses. R^2 refers to within R^2 in columns with individual fixed effects.

column 3, the difference-in-difference estimate for 2009 was around DKK 2,200 in this subsample, or only around 25 percent of the analogous estimate in the full sample. However, this partly reflects a difference in the timing of the spending effect. When cumulating the difference-in-difference estimates for 2008 and 2009 instead of focusing only on 2009, the effect in the subsample of "renters" is DKK 5,100, or around 40 percent of the effect in the full sample (see online Appendix Table A2).[12]

In the following columns, we provide a quantitative analysis of the relationship between the borrowing and spending effects. Formally, we employ an instrumental variables framework where the dependent variable is the change in spending from 2006–2007 to 2008–2009, the main explanatory variable is the change in borrowing from (the end of) 2007 to (the end of) 2009 and the instrument is an indicator

[12] In unreported regressions, we have also applied the baseline model to the full sample while excluding individual-years where a real estate transaction takes place to obtain another measure of the effect on consumer spending. The difference-in-difference estimates are similar to those obtained for renters in 2008 and more than twice as large in 2009; however, the coefficients are less precisely estimated. The point estimates suggest that more than 50 percent of the drop in spending was unrelated to real estate purchases.

of having an exposed primary bank in 2007. Thus, we are effectively asking how much spending decreases when a contraction of the credit supply causes borrowing to decrease by one unit. The first stage shows a relative decrease in borrowing of around DKK 11,600 (column 4) and the second stage yields a significant point estimate just below unity (column 5). These results imply that the magnitude of the spending effect is very similar to the magnitude of the borrowing effect: a unit decrease in borrowing translates into almost exactly a unit decrease in spending.

The parameter identified by the instrumental variables framework is the *marginal propensity to spend out of borrowing*, which is a very different concept than the *marginal propensity to consume out of liquidity* (Gross and Souleles 2002). While the latter measures how household consumption responds to changes in borrowing opportunities, the former captures how spending varies with actual borrowing. Interestingly, this parameter expresses the extent to which own funds and borrowed funds are substitutes or complements in household spending decisions. On the one hand, if households make purchases with their own funds instead of borrowed funds when credit is restricted, it is smaller than unity. On the other hand, if households refrain from making purchases that would have been financed with a mix of own and borrowed funds when credit is restricted, it is larger than unity. Our empirical results suggest that, on average across the consumers affected by the credit supply shock, borrowing is neither a substitute nor a complement to own funds.

Next, we document consumption responses to the credit supply shock using information from an entirely unrelated source: the auto register. Column 6 shows that customers in exposed banks exhibited a relative decrease in the propensity to own a car of around 0.003 during the crisis. This suggests that 1 out of roughly 330 customers in exposed banks did not own a car while they would have owned one, had they been customers in nonexposed banks. In addition, column 7 shows that the propensity to own two cars or more decreased by 0.0014 during the crisis suggesting that 1 out of roughly 700 customers in exposed banks owned at most one car whereby they would have owned at least two cars, had they been customers in nonexposed banks. The effect on the stock of cars persisted but did not increase further in the postcrisis period.

Finally, we report results relating to real estate spending in Table 6. Column 1 shows that the average public property valuation of real estate owned by customers in exposed banks decreased by around DKK 9,500 relative to customers in nonexposed banks during the crisis and remained lower through the postcrisis years. This suggests that households with a demand for better housing were more likely to either remain in their existing home or acquire a less expensive home than desired if they were customers in exposed banks.[13]

We study each of these two channels in turn. First, as shown in column 2, we find that customers in exposed banks exhibited a small and statistically insignificant decrease in the propensity to purchase real estate of around 0.06 percentage points during the crisis relative to customers in nonexposed banks. Second, we estimate the effect on the characteristics of newly acquired real estate by restricting the sample to individual-years where a real estate purchase took place. Compared to the full baseline model, we drop individual fixed effects to avoid restricting the identifying variation

[13] Note that the magnitude of the estimate cannot be compared directly to the estimated effect on imputed spending since public property valuations do not equal the market price.

Table 6—Real Estate

			Outcomes conditional on purchase		
	Appraisal value (DKK) (1)	Purchase of real estate (dummy) (2)	Δ appraisal value (DKK) (3)	Δ total debt (DKK) (4)	Δ property size (m2) (5)
Exposed			13,332	−3,781	0.284
			(3,382)	(6,828)	(0.134)
Crisis × exposed	−9,486	−0.000672	−64,298	−46,348	−1.138
	(4,189)	(0.00125)	(13,277)	(13,600)	(0.293)
Postcrisis × exposed	−10,316	−0.00131	−17,837	−18,036	−0.137
	(5,463)	(0.00113)	(10,186)	(8,960)	(0.207)
Fixed effects					
Covariates-time	Yes	Yes	Yes	Yes	Yes
Municipality-time	Yes	Yes	Yes	Yes	Yes
Industry-time	Yes	Yes	Yes	Yes	Yes
Individual	Yes	Yes	No	No	No
Observations	1,300,723	1,310,071	176,737	176,737	173,073
R^2	0.075	0.044	0.255	0.203	0.017

Notes: Table 6 reports estimates from the compact baseline model with individual-level outcomes: total appraisal value of real estate (column 1) and an indicator of purchasing real estate (column 2). These outcomes are averaged within the time periods 2005–2007 (precrisis), 2009 (crisis), and 2010–2011 (postcrisis) and winsorized at the first and ninety-ninth percentile. The regressions use the full sample of individual-period observations. Table 6 also reports estimates from a modified model with individual-level outcomes: the change in the total appraisal value of real estate (column 3), the change in total debt (column 4), and the change in the habitable surface of real estate (column 5). These outcomes are not averaged within periods. The regressions use the sample of individual-year observations where a real estate purchase takes place. Exposed indicates that the loans-to-deposits ratio of the individual's primary bank in 2007 was above the sample median. Covariates include categorical controls, all measured in 2007, for age, educational level, gender, home ownership, partner, unemployment spells during past 24 months, deciles of bank debt, deciles of income. Municipality fixed effects are indicators for each of the 98 municipalities and industry fixed effects indicators for 9 occupational industries. Standard errors are clustered at the level of the primary bank in 2007 and are reported in parentheses. R^2 refers to within R^2 in columns with individual fixed effects.

to the limited number of individuals who bought several homes during the sample period, but retain all other controls. Column 3 shows that the increase in the public property valuation triggered by a real estate transaction fell by around DKK 64,000 for customers in exposed banks relative to customers in nonexposed banks during the crisis. Consistent with the findings for imputed spending, the difference between the two groups largely vanished after the crisis. Similarly, there were differential decreases in the average new debt of around DKK 46,000 (column 4) and in the gain in home size of around 1.1 square meters (column 5) during the crisis. These results are strongly suggestive that customers in exposed banks were induced to buy smaller and less valuable homes when their banks tightened credit in response to the financial crisis.

VII. Results: Heterogeneous Effects

It should be expected that the effect of a credit supply shock on household borrowing and spending differs across household with different ex ante levels of liquidity. First, liquid households presumably have a lower credit demand; it is not obvious why they would finance purchases with debt if they could pay for them with their own liquid funds. Second, when liquid households demand credit to make purchases that exceed their own liquidity, for instance a house, banks' credit risk, and thus the

informational barrier to lending, should be lower given the households' ability to co-finance with own funds.

In this section, we estimate the effect of being a customer in an exposed bank on credit and consumption outcomes at different ex ante levels of liquidity. Specifically, we first split the sample into five liquidity quintiles based on the distribution immediately before the crisis. Liquidity is measured as the total balance on an individual's checking and savings accounts. We then estimate the baseline model separately for the bottom 20 percent, the middle 60 percent, and the top 20 percent of liquidity. Individuals in the bottom quintile held liquidity of less than DKK 3,600 in 2007 whereas the top quintile held liquidity in excess of DKK 78,000. By comparison, the average monthly disposable income in 2007 was around DKK 16,000.

Figure 8, panel A, illustrates the results for total debt. Within the bottom decile of liquidity, the debt of customers in exposed banks decreased quickly relative to customers in nonexposed banks and the divergence continued throughout the sample period; the difference-in-difference estimate for 2011 was around DKK −20,000. Within the top decile of liquidity, the divergence was slower and there are signs of a reversal at the end of the sample period; the effect was largest in 2010 at around DKK −10,000 and dropped to a statistically insignificant DKK −5,900 in 2011. In every year, the estimated decrease in borrowing within the middle quintiles falls between the estimates for the top and bottom quintiles.

Figure 8, panel B, illustrates the analogous results for spending. Within the bottom decile of liquidity, customers in exposed banks reduced spending immediately after the crisis relative to customers in nonexposed banks and the difference-in-difference estimates remain negative and statistically significant during the postcrisis years. Within the top decile of liquidity, the difference-in-difference estimate is only negative for 2009 and always far from statistical significance. Again, the estimated effects vary monotonically with liquidity in every year.

The results should be interpreted with caution for at least two reasons. First, although the point estimates strongly suggest that ex ante liquidity plays an important role in determining the effect of the credit supply shock, the precision of the estimates is generally low and the differences between liquidity groups are not statistically significant. Second, it is conceivable that the consistent differences across liquidity groups are not caused by liquidity itself but by other household characteristics, observable or unobservable, that correlate with liquidity.

VIII. Conclusion

This paper has studied whether the financial crisis spread from distressed banks to households through a contraction of the credit supply. We first argued that banks with a large reliance on non-deposit funding and many assets tied up in illiquid loans were especially exposed to the global credit crunch associated with the financial crisis in 2007–2008 and documented that banks with a high loan-deposit ratio in 2007 reduced their credit supply significantly in the following years relative to banks with a low loans to deposits ratio. We then showed that customers in exposed banks reduced their total borrowing as well as consumption after the financial crisis relative to customers in nonexposed banks suggesting that the tightening of credit by banks exposed to the crisis had significant adverse effects on the households that were their customers.

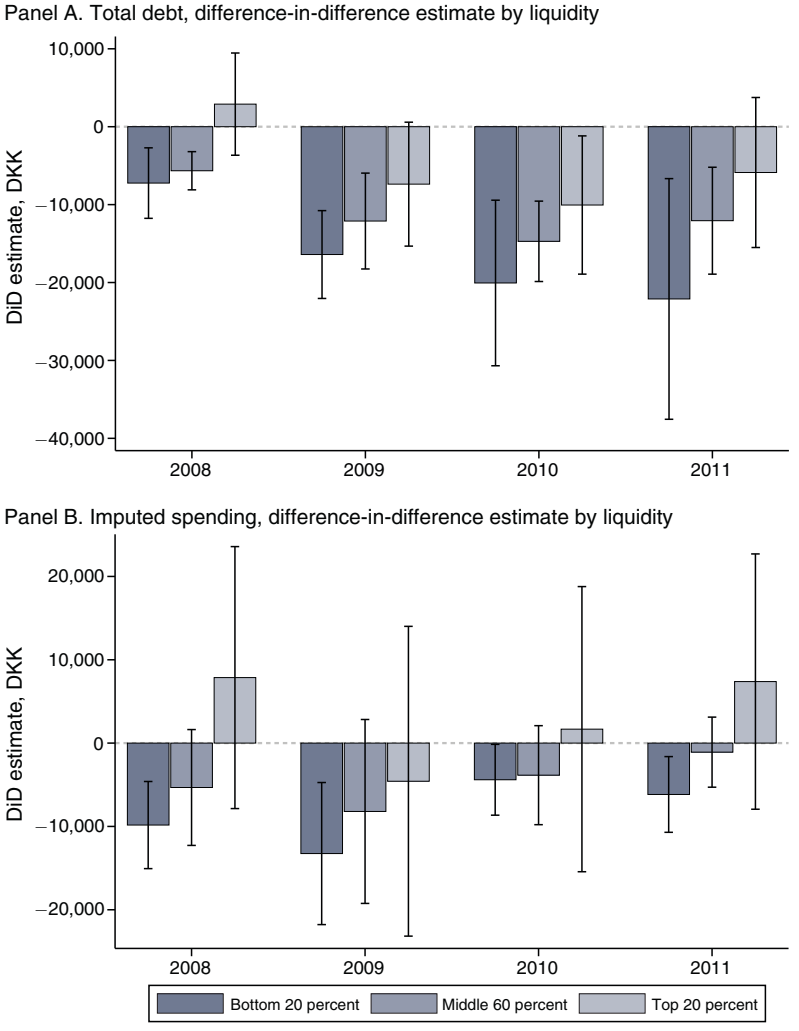

FIGURE 8

Notes: Panels A and B illustrate the results from the baseline model where the dependent variable is total debt and imputed spending respectively and the sample is split by liquidity in 2007. The black dots represent the estimated coefficients on the interaction terms between time dummies and a dummy for individuals whose primary bank in 2007 was exposed to the financial crisis. The gray bars represent 95 percent confidence intervals of the point estimates based on standard errors clustered at the level of the primary bank in 2007. The model includes individual characteristics, industry dummies, and municipality dummies, all measured in 2007 and interacted with a full set of time dummies, as well as individual fixed effects. Precise point estimates and standard errors are reported in Table A4 in the online Appendix.

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