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Banks' supply of long term credit after a liquidity shock: Evidence from 2007-2009

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Abstract

We study the real effect on banks' credit supply after a negative liquidity shock. Controlling for demand effects, we take advantage of the exogenous international interbank market freeze in 2007-2008 to assess the causal relation between French banks' liquidity risk and their lending. We find that banks with a lower funding risk and a lower ratio of long-term loans to long-term funding and deposits provide more loans after the shock. The difference in lending between banks only exists for long-term loan supply. Small firms bear the decline in long-term lending.

Keywords: financial institutions, liquidity risk, loan maturity

JEL: G01, G21, G28.

L'offre de crédit de long-terme des banques après un choc de liquidité: le cas de 2007-2009

Résumé

Nous étudions les effets sur l'offre de crédit d'un choc de liquidité négatif. En contrôlant pour les effets de demande de crédit, nous exploitons le choc exogène qu'a constitué le gel du marché interbancaire international en 2007-2008 pour analyser la causalité entre le risque de liquidité des banques françaises et leur offre de crédit. Nous trouvons que les banques ayant un risque de financement plus faible et un ratio de crédit long-terme sur financements de long-terme et dépôts plus faible offrent plus de crédit après le choc. La différence d'offre de crédit existe uniquement pour l'offre de crédit long-terme. La diminution de l'offre de crédit de long-terme est subie par les entreprises de petite taille.

Mots-clés: institutions financières, risqué de liquidité, maturité des crédits

JEL: G01, G21, G28.

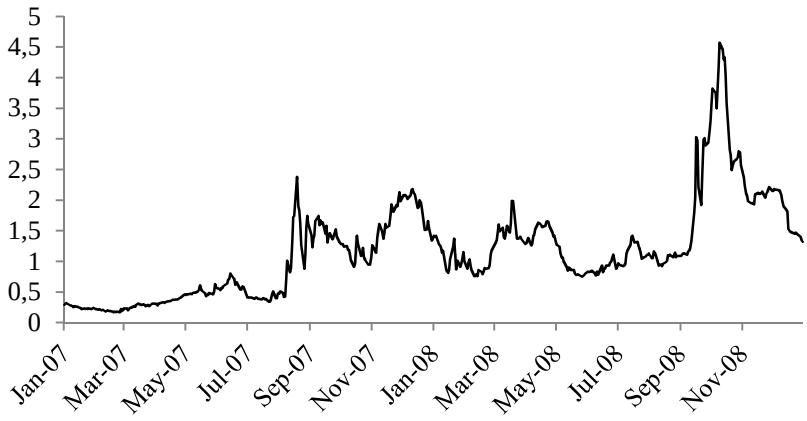
Introduction

Long-term loans are a primary source of funding for firms' investment. If a liquidity shock causes banks to reduce their long-term loans, firms might be forced to stop their investment. So it is of primary interest to take into account loan maturities to analyse the effects of a liquidity shock on the real economy. Surprisingly this issue has received little attention so far in the literature.

We propose to fill this gap in analysing the adjustment in loan maturities after a liquidity shock. We analyse (i) which banks' characteristics make them more resilient (resilience is defined below) to a liquidity shock, (ii) how the maturity of credit supply is affected by the shock, (iii) which type of non-financial firms is the most severely hit by the reduction in credit supply. We use the 2007-2009 financial crisis as a natural experiment of a liquidity shock. During the crisis, interbank refinancing spreads increased dramatically (figure 1). This situation caught up banks by surprise as they were used to an environment of liquidity abundance before August 2007 (Brunnermeier, 2009). The liquidity shock culminated in a paralysis of the interbank market after the failure of Lehman Brothers in September 2008. This funding stress creates a perfect framework to test what characteristics make banks more resilient to a liquidity shock and how they adjust their maturity of lending.

We focus on the French credit market to non-financial firms. The initial liquidity shock in the summer of 2007 can be considered as exogenous to the French economy. The shock originated in the US subprime mortgage market, propagated to the international banking market and then affected the real sector in France. There was no burst of any real estate bubble in France. This creates a proper set up to test the effect of banks' liquidity risk on their credit supply to non-financial firms.

Fig. 1: 3 months USD Libor - T bill spread (in %)



Source: SNL and authors' own calculation.

Our analysis proceeds in several steps. First, we check which banks' characteristics make them resilient to a liquidity shock. We define a *resilient bank* as a bank that lends more than other banks after the liquidity shock. To do this we analyse how bank's credit supply after the liquidity shock is affected by (i) the liability structure of the bank, (ii) the maturity mismatch between the asset and the liability of the bank. This step helps to identify which characteristics are the most relevant to measure liquidity risk in the rest of the paper.

In a second step, we analyse whether the change in loan supply was particularly pregnant for a particular type of loan maturity. A reduction in long-term loans might have more severe consequences as they are an important source of financing for investment in new projects. Table 1 reports loan exposure of French non-financial firms in 2007Q2 just before the liquidity shock. It shows that non-financial firms rely heavily on long-term maturities. This is especially striking for small firms with a turnover below 1 million of Euros: long-term financing represents on average 88% of their total loan exposures. We assess whether banks' with a higher liquidity risk adjusted their lending for a particular maturity. Our main focus is to check whether long-term lending is affected by the liquidity shock.

Third, we analyse which type of borrowers were particularly affected by the reduction in loan supply. Opaque firms should bear the burden of the liquidity shock as it is harder for banks to evaluate the quality of their management. However, rationing this type of borrowers implies more severe consequences as small and opaque firms are generally unable to substitute capital market financing for bank lending.

To properly assess the behaviour of banks, a major challenge is to identify separately supply effects from demand effects. After August 2007, the deterioration of the national and international economic outlooks decreased investment opportunities for firms, lowering their credit demand. To control for change in credit demand and properly identify the change in credit supply, Khwaja and Mian (2008) proposed a methodology based on bank-firm credit relationships. We implement their approach with a highly disaggregated database from the Banque de France reporting bank-firm credit exposures quarterly. We take advantage of the numerous firms having multi-banking relationships to measure the change in credit for a given firm. When several banks lend to the same counterparty, it allows us to measure how banks with different characteristics changed their lending towards the same firm. In this empirical framework, we are thus able to control for all the effects of firms' characteristics such as firm's credit risk and firm's credit demand. Thus we analyse the change in bank credit supply between 2007 and 2009 for several banks lending to the *same* counterparty.

Our identification strategy is similar to a difference-in-difference methodology where the treatment is the exposition to the liquidity shock. Rather than using a treatment group and a control group we considered that all banks are treated but with different intensity.

The closest papers to our work are Iyer et al. (2014), Kapan and Minoiu (2014), Cornett et al. (2011) and Ivashina and Scharfstein (2010). These papers analyse bank lending supply during the 2007-2008 financial crisis, but they do not highlight the causality between the liquidity risk of banks and the maturity of the loan they grant after the shock. Our paper fills this gap by looking at credit maturity. We contribute to the literature in several ways. First, our approach uses several measures of funding risk and maturity mismatch. This paper is the first (to the best of our knowledge) to rely on the residual maturity of banks' balance sheet to measure funding risk and maturity mismatch at bank level. It thus contributes to the debate on liquidity regulation which aims at building a more resilient banking sector by impeding banks to do maturity transformation up to a certain threshold.[1]

Secondly, this paper analyses the effect of a liquidity shock on the maturity of credit. Non-financial firms strongly rely on long-term loans. So distinguishing the effect of a liquidity shock on long-term loan and short-term loan can highlight composition effect that a broad view on loan supply would not.

Our main results show that (i) banks with more deposits and long term funding reduce loan supply proportionally less, (ii) maturity mismatch properly captures banks' resilience only when the maturities and nature of assets and liabilities are taken into account, (iii) the credit rationing is driven by long-term loans: non-resilient banks reduce their supply of long-term loans, whereas all banks have similar behaviour regarding the supply of short term loans, (iv) small firms bear the decline in the supply of long term loans from non-resilient banks.

Some policy implications arise from this paper. The Basel III NSFR liquidity regulation mainly relies on deposits and long-term liabilities (BCBS, 2014). The paper supports this approach and gives some insight on how the future liquidity regulation might strengthen the financial stability of banks. From a policy point of view, it shows that this regulation has positive macroeconomic implications by limiting banks' balance sheet shrinkage.

The rest of the paper is organized as follows. Section 1 presents related literature and hypotheses. Section 2 presents the methodology and data. Section 3 presents the results. Section 4 concludes.

[1] The Basel III Net Stable Funding Ratio (NSFR), which will come into force on the 1st January of 2018, prevents banks to increase their maturity mismatch above to a certain threshold. In this regulatory framework, banks should fund long term and illiquid assets with stable funding such as deposits and liabilities with residual maturity over one year (BCBS 2014).

1. Literature review

This paper belongs to two strands of literature (i) the transmission of liquidity shock to the real economy, and (ii) the measuring of strengths and weaknesses of bank's balance sheet with regard to liquidity.

Theoretical papers of financial frictions show that liquidity shocks are transmitted to the real economy through frictions at the bank level and firm level (Bernanke and Blinder, 1988; Bernanke, Gertler and Gilchrist, 1999; Holmström and Tirole, 1997). Empirical papers analyse the credit channel using correlation at the aggregate level (Bernanke, 1983), cross-section analysis at the bank level (Kashyap and Stein, 2000) or natural experiments (Khwaja and Mian,2008, Schnabl 2012, Iyer et al. 2014 and Kapan and Minoiu, 2014).

Khwaja and Mian, (2008), Schnabl (2012) and Iyer et al. (2014) use credit register data to determine how liquidity shocks affect lending supply. We follow the same empirical strategy by using the 2007-2009 interbank market freeze as an exogenous liquidity shock and by relying on credit register data to estimate the change in loan supply. However, we contribute to this literature by analysing the impact of a liquidity shock on the maturity of loan supplied after the shock. In particular, we assess whether the shock affects the provision of long term loans. In addition, we use firm level data – size – to show how firms' opacity affects their ability to receive credit after the shock.

This paper is also related to an emerging literature trying to capture the strengths and weaknesses of bank's balance sheet with regard to liquidity (e.g., Berger and Bouwman, 2009; Brunnermeier, Gorton and Krishnamurthy, 2011, 2012). In this paper, we compare how different characteristics of banks' balance sheet make them more resilient to a liquidity shock. We have access to balance sheet residual maturity data. This allows us to capture the maturity mismatch of banks as well as their reliance on stable funding. This information is particularly useful to give insights on the potential benefits of the future Basel III NSFR liquidity regulation.

2. Data and methodology

2.1. Data

We employ three different databases in the study. The loan level data comes from the *Banque de France* credit registry. The bank level database comes from the French prudential

regulation authority (*Autorité de Contrôle Prudentiel et de Résolution*, ACPR). Finally, firm level data comes from the Banque de France database on non-financial firms.

2.1.1. Loan level data

The credit registry database of the *Banque de France* describes loans granted by banks to all firms in France. Each line describes the credit exposure of a bank to a firm as soon as the exposure is greater than 25K€. The database is updated quarterly. Information on maturity is provided and we can distinguish between short-term and long-term loans (i.e. loans with a maturity greater than one year). To identify the effect of maturity transformation risk on credit during the financial crisis, we consider two periods: 2007Q2 and 2009Q4. As the first frictions on the interbank market occurred in August 2007 (cf. figure 1), the credit registry in 2007Q2 gives the credit exposure of banks to non-financial firms just before the onset of the financial shock. The credit registry in 2009Q4 gives the credit exposure of banks to each non-financial firm after the shock.[2]

We remove financial institutions from the sample of borrowers. For the remaining firms, we keep all bank-firm relationships that appear at both dates and measure the change in credit at the bank-firm level by the change in their respective credit exposure between 2007Q2 and 2009Q4. Hence we focus here on the intensive margin. Finally, we remove firms that have a single banking relationship as our identification strategy relies on firms' borrowing from several banks. We proceed with the same methodology to compute the change for long-term and short-term lending. We also focus on the intensive margin for long-term and short-term lending.

Panel A of table 2 presents descriptive statistics at the loan level. The average credit exposure in 2007Q2 is 0.849 Million Euros, with a huge variation between counterparties (the standard deviation is 9.505 million of Euros). This reflects the fact that the database covers borrowers from very small entities to large multinational firms.

The change in overall lending between 2009Q4 and 2007Q2 is strongly negative, at -10.9% on average. This confirms that the credit exposure to non-financial firms sharply falls during the crisis in France. The change in long-term loans is even slightly more negative at -11.9%. However, the change in short-term credit exposure is 'only' -3% on average. This suggests

[2] In unreported results, we also tested other periods, namely 2007Q2-2009Q1, 2007Q2-2009Q2, 2007Q2-2010Q2 and 2008Q3-2009Q2. The main results, available upon request, remain qualitatively unchanged.

that the decrease in loan supply after the liquidity shock might be driven by long-term loans. Next, we match this loan-level dataset with bank level data.

2.1.2. Bank level data

The bank level database contains financial statements at non-consolidated level. The sample covers all commercial and cooperative banks operating in France over 2007Q2-2009Q4. The data covers detailed information on balance sheets and financial statements. In addition, the data describes residual maturities for assets and liabilities, which is crucial to study impacts of bank's maturity mismatch.

Some banks merged between 2007Q2 and 2009Q4. This could lead to artificial increase in credit exposures to certain borrowers. To correct for this potential bias, we take into account mergers and acquisitions between banks in aggregating data of the concerned entities prior to the event.

We only consider large and medium sized banks, i.e. banks having at least thousand bank-firm relationships in the credit registry. Our sample ends up with 133 banks at the unconsolidated level, representing 76% of banking credit to the real economy in 2007Q2 in France.

Panel B in table 2 gives some descriptive statistics on bank level data. In our sample banks have an average asset size of 39 billion euros, and the median is 8.9 billion euros. A large fraction of their activity is dedicated to lending: the median share of loans to customers over total assets is worth 67.8%. Deposits and liabilities with a maturity over one year constitute a large share of their liabilities with a median value at 64.7% of their total assets. The loan to deposit ratio has a median of 1.282. However, the loan to stable funding is below 1 with a median at 0.822. Banks appear to use long term funding as alternative to deposits to finance loans.

2.1.3. Firm level data

The firm level database reports yearly information on all firms operating in France. To distinguish firms by size, we consider firms' turnover in 2007Q2 (see panel C of table 2). There are 119,041 firms in our sample. Firms with a turnover below 1 million euros or with

no information on turnover[3] are considered small. They represent 70.6% of our sample. Firms with a turnover between 1 and 100 million euros are considered medium. They represent 28.5%. Firms with a turnover over 100 million euros are considered large. They represent the remaining 0.9% of the sample.

2.2. Methodology

Our empirical strategy is to determine how non-resilient banks adjust their loan supply compared to other banks after the liquidity shock.

2.2.1. Measuring banks' resilience to a liquidity shock

We aim at comparing banks' characteristics to determine what makes a bank more resilient to a liquidity shock. Cornett et al. (2011) show that deposits were a stable source of funding during the 2007-2009 financial crisis. The Basel III NSFR regulation also considers deposits as a stable source of funding. Our first proxy of stable funds is the share of deposits over total assets.

Liabilities with a maturity above one-year is a second source of stable funding as a bank with more long-term financing does not face an immediate pressure to roll-over its debt in times of stress.[4] Again, the Basel III NSFR regulation considers funding with a maturity over 1 year as a stable source of funding. We thus define the stable funding ratio as the share of (deposits + liabilities with a residual maturity over 1 year) over total assets of the bank.

These two ratios define our measures of funding risk: a bank with a high ratio is expected to bear a lower funding risk. However, measuring the funding risk might not be sufficient to capture the resilience of banks to a liquidity shock. Banks might have a low funding risk but a high maturity mismatch. We introduce three maturity mismatch ratios to capture this. The first is a simple loan-to-deposit ratio. It is defined as $loans/deposits$. This ratio might be better at capturing banks' resilience as banks with a high ratio rely on potentially instable source of funding to finance their loans. The last two maturity mismatch ratios we employ are long-term loans over deposits and long-term loans over stable funding. Long-term loans are loans with a residual maturity over one year. Stable funding again refers to the sum of deposits and

[3] It is not compulsory for firms with a turnover below 0.75 Million euros to report detailed financial accounts.

[4] Remember that the maturity we measure on the liabilities of bank's balance sheet is not initial but residual. So we are sure that the bank will not have to roll over that debt during at least a year.

funding with a residual maturity over one year. Formally, they are defined as $Long\ term\ loans\ to\ deposits = loans\ with\ a\ residual\ maturity\ over\ 1\ year/deposits$ and

$$Long\ term\ loans\ to\ stable\ funding = \frac{loans\ with\ a\ residual\ maturity\ over\ 1\ year}{deposits+liabilities\ with\ a\ residual\ maturity\ over\ 1\ year}.$$

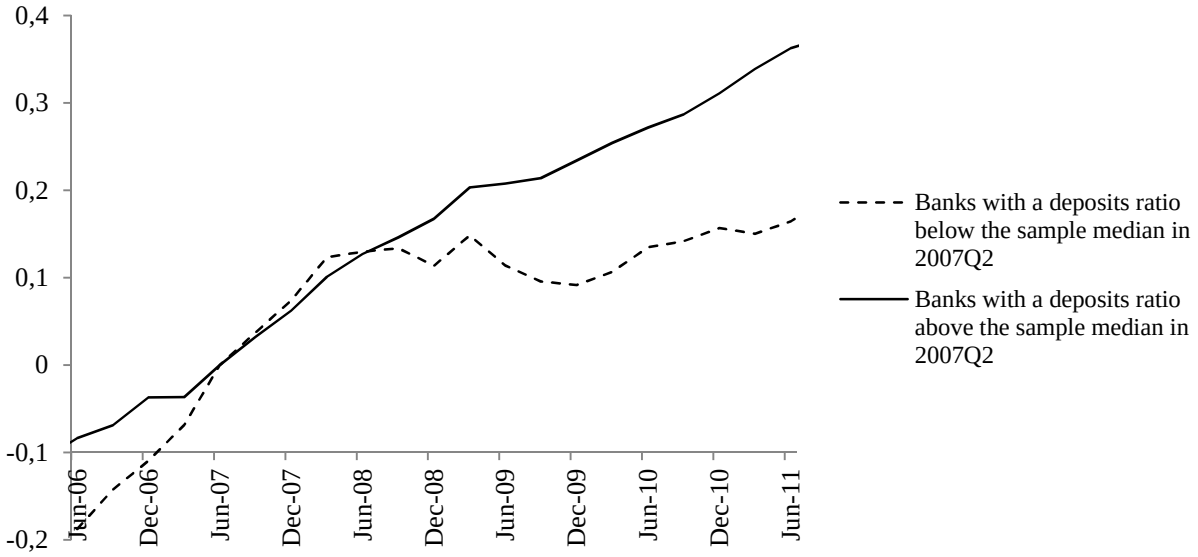
The last two ratios capture the relation between long-term assets and stable funding. This distinction helps to determine whether the one year threshold retained in the regulation matters in practice. A higher maturity mismatch ratio should indicate a bank more vulnerable to the liquidity shock.

2.2.2. Identification strategy

We study how banks adjust the maturity of their loans during a liquidity crisis, depending on their liability structure and their maturity mismatch prior to the crisis. Our approach is similar to a difference-in-difference model where the intensity of the liquidity risk explains banks' loan supply. The different liquidity ratios described in the former part will be tested. Figure 2 summarizes our approach for the deposit ratio. The graphic shows the evolution of banks credit exposure in deviation to the June 2007 level, i. e. just before the shock, and for the two subsamples of banks. The plain line shows the evolution of credit exposure to non-financial firms for banks with a deposits ratio above the sample median in June 2007. The dotted line shows the evolution of credit exposure to non-financial firms for banks which have a deposits ratio under the sample median in June 2007. Credit exposure evolution strongly differs after the financial crisis started. In particular, banks with a low deposits ratio strongly reduced their credit exposure, whereas for the other group of banks, credit exposures continued to grow. The positive credit growth trend for the resilient group of banks appears to be constant over the period. For the group of non-resilient banks, credit growth is high before the shock and then abruptly declines after March 2008.

We focus on the French banking system at the unconsolidated level over 2007Q2-2009Q4. The freeze in European interbank markets can be considered as exogenous to the French banking sector. This natural experiment provides a setting where we can test the effect of an exogenous financial shock on banks' lending behaviour.

Fig. 2: Credit exposure of banks to non-financial firms
(billion euros, deviation from June 2007 level)



This figure shows the evolution of banks' logarithm of credit exposure to non-financial firms in France. The plain line shows the evolution of credit exposure for banks having a deposits ratio above the sample median. The dotted line shows the evolution of credit exposure for banks having a deposits ratio below the sample median. Exposures are expressed in difference with respect to the 2007Q2 level for each bank, then aggregated up for the two groups.
Source: Banque de France credit registry, banks' financial statements collected by the French Prudential Authority (ACPR) and authors' own calculations.

An important remaining identification challenge is to disentangle supply effects from demand effects of credit. To cope with this issue, we follow Khwaja and Mian (2008) methodology. The identification strategy relies on the fact that a large proportion of borrowers have several banking relationships over the period considered. Thus, it is possible to study how several banks adjusted their lending to the *same* counterparty. By doing so, we control for possible demand bias (if demand was low for a particular group of banks) and other borrowers' characteristics such as risk and investment opportunities. In practice, it consists in putting firm fixed-effects in the specification. Fixed effects capture firms' heterogeneity and remove the suspicion of an omitted variable bias that could be correlated with banks' characteristics.

Finally, we add banking group fixed effects in our specification. As some banking groups in France might be more exposed to the liquidity shock and have different management of intra-group liquidity, we check whether the banking group characteristic drive our results. They are six banking group in our dataset which correspond to the six main banking groups in France.[5]

[5] Including banking group fixed effects forces us to remove from our sample foreign subsidiaries when they do not constitute a banking group in France. Thus, for most specifications, we report results with and without banking group fixed effects. Note that foreign subsidiaries do not account for a large share of the credit market in

Thus, we analyse how banks' individual characteristics prior to the crisis affect their loan supply to the *same* counterparty inside the *same* banking group. This strategy allows identifying a causal relation between the level of liquidity risk at the individual level and the change in credit supply. Equation (1) describes the main model of interest in the paper:

$$Lending_{b,f} = \propto_f + \delta_g + \beta_1 . Bank's\ resilience_b + \gamma . Control\ variables_b + \varepsilon_{b,f} \quad (1)$$

Where $Lending_{b,f}$ is the difference in the log of lending by bank b to firm f between 2007Q2 and 2009Q4. $Lending_{b,f}$ is either the change in lending irrespective of maturity (first step) or the change in lending for long-term loans and short-term loans (second step). The variable $Bank's\ resilience_b$ is alternatively the deposits ratio, the stable funding ratio, the loan-to-deposit ratio, the long-term loans to deposits and the long-term loans to stable funding. $\beta_1$is our main parameter of interest to be estimated. $Control\ variables_b$ are bank characteristics and γ is a vector of parameters to be estimated. We consider five banks' characteristics that could influence loan supply: size (logarithm of total assets), profitability (ROA), non-performing loans ratio (non-performing loans over total assets), business model (credit over total assets) and solvency (equity over total assets). All independent variables are measured prior to the shock in 2007Q2. α_f are firms' fixed effects capturing firm heterogeneity. δ_g are banking groups' fixed effects capturing banking group heterogeneity. Standard errors are clustered at the bank level.

3. Empirical results

3.1. What drives banks' resilience to a liquidity shock?

3.1.1. Funding risk and loan supply after the shock

We start our analysis by considering how the funding risk of banks affects their supply of credit after a shock. In this first step, we check if our two ratios – the deposits ratio and the stable funding ratio – capture well the funding risk of credit institutions. Table 3 reports the results of our model. We start our estimations by regressing the change in lending for all maturities on the funding risk without including borrowers' fixed effects. These estimates in

France. Moreover, empirical evidence suggests that excluding foreign subsidiaries should result in more conservative estimates as these subsidiaries tend to behave pro-cyclically (see e.g. Albertazzi, 2014).

column (1), (2), on the one hand, and (6), (7) on the other hand, are thus potentially biased by demand effects and other borrowers' characteristics. We report them to allow comparison with the regressions where borrowers' heterogeneity is controlled for. Both the deposits ratio and the stable funding ratio appear to have a positive effect on lending. The coefficients are statistically and economically significant. A one-standard deviation increase in the deposits ratio implies a difference in lending between two banks of $0.213 \times 0.104 = 2.2\%$. The order of magnitude is comparable for the stable funding ratio.

When we include borrowers' fixed effects, the coefficients for both ratios remain statistically significant and of the same order of magnitude. We thus do not find evidence that results are driven by demand effects or other characteristics of the borrowing firms. Finally, results remain robust when we include banking group fixed effects. The regressions indicate that two banks with a different funding risk inside the same banking group and lending to the same counterparty appear to behave differently when hit by a liquidity shock. The bank with a lower deposit base or with less stable funding reduces its supply of loans as a consequence of the shock.

3.1.2. Maturity mismatch and loan supply after the shock

We next consider how maturity mismatch predicts banks' behaviour after the shock. Considering funding risk alone does not take into account the liquidity risk on the asset side. We test whether considering maturity mismatch brings additional information on banks' resilience to a liquidity shock. Table 4 reports regression results for our maturity mismatch ratios: the loan-to-deposit ratio, the long-term loans to deposits ratio and the long-term loans to stable funding. Columns (1) and (2) report results for the loan-to-deposit ratio. We find mixed evidence that the loan-to-deposit influence lending after the shock. The coefficient is only significant when we do not control for banking group effects.

When we consider the long-term loans to deposits, results are more clear-cut as both coefficients in columns (3) and (4) are highly significant. Thus taking into account the share of loans without their maturity appear to be less informative on the liquidity risk of the bank. Economically, the predicted effect remains however quite small. An increase in the long-term loans to deposits from the median value of the sample to the 75^{th} percentile implies a change in loan supply of $1.47 \times -0.002 = -0.3\%$. This is much lower than what was predicted by the deposits ratio and stable funding ratio. Finally, column (5) and (6) reports the results for the long-term loans to stable funding ratio. Only this ratio appears to be both statistically and

economically significant. An increase in this ratio from the median value to the 75th percentile of the distribution implies a change in loan supply of $0.181 \times -0.127 = -2.3\%$. These results strongly suggest that a maturity mismatch indicator should rely both on deposits and long-term funding to assess the stability of banks' funding. It should also take into account the maturity of the loan portfolio to properly assess the liquidity risk coming from the asset side of the balance sheet.

3.2. Liquidity shock and the change in lending maturity

The literature on liquidity shock transmission focuses on the overall change in lending without distinguishing by maturity type. However, firms' investment relies mostly on long-term loans as potential cash-flows to repay the loan will only appear after a certain period of time. The macroeconomic consequences of a credit rationing of long-term loans might thus be more severe than a temporary reduction in short-term lending. In the next step, we estimate how banks liquidity risk affects the change in lending for long-term loans and short-term loans separately.

3.2.1. Change in long-term lending after a liquidity shock

Table 5 reports results of the change in long-term lending after the liquidity shock. The dependent variable is the change of the logarithm of long-term credit exposures between 2007Q2 and 2009Q4. Long-term credit exposures are exposures with a maturity greater than one year. We test the effect of all our proxies for funding risk and maturity mismatch prior the shock. For all these proxies, columns in the table report results with and without the inclusion of banking group fixed effects. The coefficients are significant for all regressions except for the loan-to-deposit ratio as previously. The effects are of the same economic magnitude as when we considered the change in lending for all maturities. In particular, banks with a low share of deposits, stable funding or a high long-term loans to stable funding ratio significantly decreased their supply of long-term loans after the shock. For example, long-term loan supply for banks with stable funding at the 25th percentile of the distribution of stable funding is $0.179 \times 0.098 = 1.75\%$ lower than for banks at the 75th percentile after the shock. For banks with a long-term loans to stable funding ratio at the 75th percentile of the distribution, the long-term loan supply is $0.496 \times 0.138 = 6.84\%$ lower on average than for banks at the 25th

percentile of the distribution. In a nutshell, the decrease in long-term loan supply after the shock appears to be severe for banks with a high liquidity risk.

3.2.2. Change in short-term lending after a liquidity shock

Table 6 reports the same sets of results for the change in short-term lending. The dependent variable is defined as the change of logarithm of short-term credit exposures between 2007Q2 and 2009Q4. Short-term credit exposures are exposures with a maturity below one year. For the sake of brevity, table 6 only reports regressions with banking group fixed effects included. However, results are unchanged for the other set of regressions without the banking group fixed effects. The table shows that liquidity risk does not affect the change in short-term loans for banks. All coefficients capturing funding risk and maturity mismatch are not significant. Thus, we do not find evidence that banks with a higher liquidity risk behave differently to the other group of banks.

This set of results suggests that banks with a high liquidity risk shortened the maturity of their loan portfolio after the shock: they reduced the supply of long-term loans but continued to lend at the same pace short-term loans compared to banks with a lower liquidity risk. The results might thus be driven by a strategy of banks highly exposed to liquidity risk to reduce their maturity mismatch after the shock.

To sum up, the change in lending seems to be driven by the change in long-term lending, whereas we do not find that banks with a high liquidity risk particularly reduced short-term lending compared to other banks. This result has potentially important macroeconomic implications, in particular if borrowers cannot substitute bank lending with other source of financing.

3.3 Which type of borrowers bear the credit rationing of long-term loans?

In this subsection, we dig deeper in our analysis to identify which borrowers particularly bear the decrease in loan supply after the shock. The premise of this analysis is that banks prefer to ration opaque customers to avoid problems of adverse-selection and moral hazard. Faced with an increase in loan price, safe (but opaque) borrowers might be tempted to turn down the loan offer, letting the bank only attract risky counterparties. Moreover, opaque firms' incentives might change if they face an increase in loan price: entrepreneurs can shift the riskiness of their projects to increase their expected returns.

To capture the opacity of the borrowing firms, we consider the size of the borrowers. We divide our sample of borrowers in three. We consider firms to be small when their turnover in 2007Q2 is below 1 million of Euros. Medium-sized firms are firms with a turnover in 2007Q2 between 1 and 100 millions of Euros. Finally, large firms have a turnover in 2007Q2 above 100 millions of Euros. We run for each subsample our main model of interest. We focus on the variables stable funding and long-term loans to stable funding as these two ratios have proven to be the most significant both statistically and economically in previous regressions. For the sake of brevity, we only report results including banking group fixed effects. However, results are very similar when these banking group fixed effects are not included.

Table 7 reports the regressions for the change in long-term lending by size of borrowers. Previous results are confirmed for small firms. Banks with a low share of stable funding or a high long-term-loans-to-stable-funding ratio decrease their supply of long-term loan. Small firms thus bear the transmission of the liquidity shock.

When we turn to medium and large firms, we do not find evidence that these subsamples bear a systematic decrease in loan supply from banks more exposed to the shock. The coefficients for stable funding and long-term loans to stable funding are statistically not significant. It indicates that on average banks with a high liquidity risk do not behave differently after a liquidity shock compared to other banks: they continue to lend at the same pace to medium and large firms. These results give support to the view that banks tend to ration in priority opaque borrowers.

Conclusion

After a negative liquidity shock, banks tend to reduce their credit supply, which in turn affects the real economy. In this study, we assess how banks' adjust their maturity of lending after such negative liquidity shock. The question is of high importance as a decline in long-term lending is more detrimental to investment financing. Moreover, if this decline is bear by opaque firms less likely to obtain alternative source of financing, the liquidity shock can cause a severe macroeconomic shock.

We take advantage of the international interbank freeze which started in August 2007 – and can be considered exogenous for the domestic French banking sector – to analyse how banks hit by a liquidity shock change their lending supply depending on their level of liquidity risk. To measure the change in lending, we have access to a rich bank-firm credit exposure dataset on a quarterly basis with information on credit maturity. This data allows us to disentangle

loan demand from loan supply effects. Moreover, we match this data with residual banks' balance sheet maturity. Our liquidity risk measures capture funding risk and maturity mismatch at bank level. Finally, we also collect information on firms' size to assess their degree of opacity for lenders.

We find that banks with more deposits and stable funding (as measured by the sum of liabilities with a residual maturity over 1 year and deposits) are more resilient to the liquidity shock, i.e. they have a higher loan supply after the shock. Maturity mismatch also explains banks' supply of credit after the shock, but the strongest economically and statistically coefficient is obtained when the mismatch is measured using residual maturity of banks' balance sheet. The difference in credit supply between banks is driven by the supply of long-term loans. More resilient banks offer more long-term loans meanwhile banks' behaviour does not appear to differ for short-term loans. Moreover, more opaque firms are particularly hit by the decline in loan supply consistently with the literature on financial frictions: small firms are the subgroups that receive less long-term loans.

These findings help to understand some of the mechanisms behind the global recession that followed the massive liquidity shock in 2007-2008. They also have important policy implications. The future Basel III NSFR regulation will prevent banks to increase maturity mismatch above a certain threshold by imposing to finance long-term and illiquid assets with stable and long-term funding. Our empirical results brings support to this regulation by showing that banks which cover their long-term loan portfolio by more stable and long-term funding were more resilient to the negative liquidity shock in 2007-2008.

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Table 1
Bank loans maturity by firm size before the liquidity shock

This table reports exposure in thousands of Euros for long-term loans, i.e. loans with a maturity over 1 year, and short-term loans, i.e. loans with a maturity below 1 year. Small firms are non-financial firms with a turnover below EUR 1M in 2006Q4. Medium firms are non-financials firms with a turnover between EUR 1 and 100M in 2006Q4. Large firms are non-financial firms with a turnover above EUR 100M in 2006Q4. *Source: Banque de France's Credit register and authors' own calculation.*

	Small firms (N = 1,712,952)	Medium firms (N=117,881)	Large firms (N=2,175)
LT loan exposure in 2007Q2 (thousands of EUR)	355	1108	33051
ST loan exposure in 2007Q2 (thousands of EUR)	131	344	13295
Share of LT over ST exposure in 2007Q2	88.34%	70.70%	41.96%

Table 2
Sample descriptive statistics

Variables	Description	N. obs.	Median	Mean	Std. Dev.
Panel A : Loan level					
Change in lending (all maturities)	Change in log of on balance sheet credit exposures (all maturities) between 2007Q2 and 2009Q4	283441	-0.176	-0.109	0.905
Change in long-term lending	Change in log of long-term credit exposures (over 1 year) between 2007Q2 and 2009Q4	233212	-0.201	-0.119	0.900
Change in short-term lending	Change in log of short-term credit exposures (below 1 year) between 2007Q2 and 2009Q4	74291	0	-0.030	1.398
Credit exposure 2007Q2	Credit exposure in 2007Q2 for all maturities in thousands of Euros	283441	163	849.22	9505.19
Long-term credit exposure 2007Q2	Long-term credit exposure in 2007Q2 in thousands of Euros	233212	153	769.05	5786.55
Short-term credit exposure 2007Q2	Short-term credit exposure in 2007Q2 in thousands of Euros	74291	78	553.66	13437.25
Panel B : Bank level					
Deposits to assets	Deposits over total assets in 2007Q2	133	0.406	0.373	0.213
Stable funding to assets	Deposits and liabilities with residual maturity greater than 1 year over total assets in 2007Q2	133	0.647	0.634	0.172
Long-term loans to assets	Loans with residual maturity greater than 1 year over total assets in 2007Q2	133	0.548	0.485	0.179
Loan to deposits	Loans over deposits in 2007Q2	133	1.591	4.916	17.197
Long-term loans to deposits	Loans with residual maturity greater than 1 year over deposits in 2007Q2	133	1.282	4.654	16.208
Long-term loans to stable funding	Loans with residual maturity greater than 1 year over stable funding in 2007Q2	133	0.822	0.795	0.326
Bank size	Ln of total assets in 2007Q2	133	15.996	15.993	1.375
Total assets	Total assets in 2007Q2 in thousands of Euros	133	8852190	38785240	146396931
Capital ratio	Equity over total assets in 2007Q2	133	0.093	0.092	0.035
NPL ratio	Non-performing loans over total assets in 2007Q2	133	0.007	0.009	0.007
ROA	Net profit over total assets in 2007Q2	133	0.004	0.005	0.003
Loans to assets	Loans over total assets in 2007Q2	133	0.678	0.593	0.212
Panel C : Firm level					
Large firms	Dummy equal to 1 if a firm has a turnover over EUR 100 Million in 2006Q4; 0 otherwise	119041		0.009	
Medium firms	Dummy equal to 1 if a firm has a turnover between EUR 1 and 100 Million in 2006Q4; 0 otherwise	119041		0.285	
Small firms	Dummy equal to 1 if a firm has a turnover under EUR 1 Million in 2006Q4; 0 otherwise	119041		0.706	

Table 3
Funding risk and loan supply after the liquidity shock

This table reports results of regressions where the dependent variable is the difference of the log of credit exposure between 2009Q4 and 2007Q2 for each bank-firm in the sample. The explanatory variables of interest are the deposits to assets and stable funding to assets computed as deposits plus financing over 1 year divided by total assets. Both variables are measured before the liquidity shock in 2007Q2. Other control variables are bank size computed as the logarithm of banks' total assets in 2007Q2, the capital ratio computed as equity divided by total assets in 2007Q2, the NPL ratio computed as non-performing loans divided by total assets in 2007Q2, the ROA computed as net income divided by total assets in 2007Q2, and the loans to assets computed as loans to non-financial customers divided by total assets in 2007Q2. Standard errors are clustered at the bank level and robust to heteroscedasticity. '***', '**' and '*' indicate statistically significant coefficients, respectively, at the 1, 5 and 10% level.

	Change in lending (all maturities)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Deposits to assets	0.104**	0.132***	0.126***	0.145***	0.109***					
	(0.052)	(0.047)	(0.045)	(0.045)	(0.041)					
Stable funding to assets						0.115***	0.102***	0.123***	0.106**	0.060*
						(0.035)	(0.039)	(0.043)	(0.050)	(0.035)
Bank size		0.002		0.012*	0.014*		0.003		0.012*	0.014*
		(0.009)		(0.006)	(0.008)		(0.009)		(0.007)	(0.008)
Capital ratio		0.615**		0.521**	0.463		0.473*		0.359*	0.451
		(0.257)		(0.210)	(0.347)		(0.285)		(0.204)	(0.361)
NPL ratio		-5.730***		-1.350	-0.774		-5.005***		-0.366	-0.255
		(1.529)		(1.014)	(1.160)		(1.569)		(0.951)	(1.095)
ROA		3.169		3.728	4.792		2.876		3.001	3.264
		(3.461)		(2.898)	(3.087)		(3.742)		(3.555)	(3.133)
Loans to assets		0.088		0.099**	0.035		0.088		0.097*	0.050
		(0.056)		(0.048)	(0.071)		(0.074)		(0.056)	(0.076)
Constant	-0.141***	-0.260	-0.148***	-0.454***	-0.442**	-0.178***	-0.280	-0.182***	-0.465***	-0.436**
	(0.020)	(0.189)	(0.018)	(0.142)	(0.180)	(0.020)	(0.200)	(0.029)	(0.164)	(0.173)
Firm FE	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Banking group FE	No	No	No	No	Yes	No	No	No	No	Yes
Observations	283,441	283,441	283,441	283,441	264,406	283,441	283,441	283,441	283,441	264,406
R-squared	0.00	.	0.45	0.45	0.47	0.00	0.00	0.45	0.45	0.47
Prob > F	0.047	<0.001	0.006	0.013	<0.001	0.001	<0.001	0.005	0.038	<0.001

Table 4
Maturity mismatch risk and loan supply after the liquidity shock

This table reports results of regressions where the dependent variable is the difference of the log of credit exposure between 2009Q4 and 2007Q2 for each bank-firm in the sample. The explanatory variables of interest are loans to deposits computed as loans divided by deposits, long-term loans to deposits computed as loans with maturity over 1 year divided by deposits, long-term loans to stable funding computed as loans with maturity over 1 year divided by stable funding. All these variables are measured before the liquidity shock in 2007Q2. Other control variables are bank size computed as the logarithm of banks' total assets in 2007Q2, the capital ratio computed as equity divided by total assets in 2007Q2, the NPL ratio computed as non-performing loans divided by total assets in 2007Q2, the ROA computed as net income divided by total assets in 2007Q2, and the loans to assets computed as loans to non-financial customers divided by total assets in 2007Q2. Standard errors are clustered at the bank level and robust to heteroscedasticity. '***', '**' and '*' indicate statistically significant coefficients, respectively, at the 1, 5 and 10% level.

	Change in lending (all maturities)					
	(1)	(2)	(3)	(4)	(5)	(6)
Loans to deposits	-0.002*	-0.001				
	(0.001)	(0.001)				
Long-term loans to deposits			-0.002***	-0.002***		
			(0.001)	(0.001)		
Long-term loans to stable funding					-0.081*	-0.127***
					(0.047)	(0.036)
Bank size	0.003	0.009	-0.001	-0.000	0.005	0.008
	(0.007)	(0.008)	(0.006)	(0.007)	(0.006)	(0.006)
Capital ratio	0.385*	0.522	0.328*	0.433	0.331*	0.397
	(0.201)	(0.346)	(0.187)	(0.333)	(0.193)	(0.355)
NPL ratio	0.007	0.254	0.082	0.429	-0.392	-0.587
	(0.938)	(1.056)	(0.908)	(1.008)	(0.978)	(1.076)
ROA	1.454	2.299	3.403	3.200	3.820	5.355*
	(2.837)	(2.706)	(2.706)	(2.647)	(2.742)	(3.066)
Loans to assets	0.088*	0.041	0.045	-0.033	0.177**	0.149**
	(0.051)	(0.072)	(0.049)	(0.075)	(0.076)	(0.065)
Constant	-0.239*	-0.332*	-0.141	-0.123	-0.276**	-0.268*
	(0.140)	(0.178)	(0.131)	(0.177)	(0.134)	(0.149)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Banking group FE	No	Yes	No	Yes	No	Yes
Observations	283,441	264,406	283,441	264,406	283,441	264,406
R-squared	0.45	0.47	0.45	0.47	0.45	0.47
Prob > F	0.04	<0.001	0.004	<0.001	0.037	<0.001

Table 5
Change in long-term lending after the liquidity shock

This table reports results of regressions where the dependent variable is the difference of the log of long-term credit exposure between 2009Q4 and 2007Q2 for each bank-firm in the sample. Long-term credit exposures are exposures with a maturity of one year or greater. The explanatory variables of interest are the deposits to assets, stable funding to assets computed as deposits plus financing over 1 year divided by total assets, long term loans to assets computed as loans with maturity over 1 year to total assets, loan to deposits computed as loans divided by deposits, long-term loans to deposits computed as long-term loans divided by deposits, long-term loans to stable funding computed as long-term loans divided by stable funding. All these variables are measured before the liquidity shock in 2007Q2. Other control variables are bank size computed as the logarithm of banks' total assets in 2007Q2, the capital ratio computed as equity divided by total assets in 2007Q2, the NPL ratio computed as non-performing loans divided by total assets in 2007Q2, the ROA computed as net income divided by total assets in 2007Q2, and the loans to assets computed as loans to non-financial customers divided by total assets in 2007Q2. Standard errors are clustered at the bank level and robust to heteroscedasticity. '***', '**' and '*' indicate statistically significant coefficients, respectively, at the 1, 5 and 10% level.

	Change in long-term lending									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Deposits to assets	0.163***	0.128***								
	(0.053)	(0.045)								
Stable funding to assets			0.180***	0.098**						
			(0.062)	(0.042)						
Loan to deposits					-0.002	-0.003*				
					(0.002)	(0.001)				
Long-term loans to deposits							-0.002***	-0.002***		
							(0.001)	(0.001)		
Long-term loans to stable funding									-0.102**	-0.138***
									(0.047)	(0.034)
Bank size	0.015***	0.012	0.020***	0.013	0.002	0.004	-0.001	-0.006	0.007	0.004
	(0.005)	(0.007)	(0.007)	(0.008)	(0.006)	(0.007)	(0.006)	(0.008)	(0.006)	(0.006)
Capital ratio	0.417*	0.300	0.234	0.265	0.272	0.350	0.209	0.246	0.192	0.209
	(0.227)	(0.449)	(0.208)	(0.459)	(0.218)	(0.436)	(0.205)	(0.429)	(0.203)	(0.452)
NPL ratio	-1.767	-1.230	-0.721	-0.873	-0.331	-0.038	-0.328	0.131	-0.768	-0.883
	(1.130)	(1.334)	(0.976)	(1.286)	(0.991)	(1.253)	(0.961)	(1.259)	(1.025)	(1.272)
ROA	6.308*	5.623*	7.151*	4.397	3.444	3.005	4.626	3.563	6.374**	6.068*
	(3.375)	(3.321)	(3.988)	(3.339)	(3.139)	(2.815)	(2.966)	(2.800)	(3.124)	(3.115)
Loans to assets	0.142***	0.035	0.141**	0.056	0.114**	0.020	0.081	-0.054	0.234***	0.156**
	(0.047)	(0.074)	(0.055)	(0.079)	(0.048)	(0.071)	(0.052)	(0.078)	(0.071)	(0.068)
Constant	-0.544***	-0.412**	-0.687***	-0.448**	-0.248*	-0.227	-0.162	-0.016	-0.316**	-0.199
	(0.132)	(0.176)	(0.184)	(0.187)	(0.134)	(0.166)	(0.135)	(0.183)	(0.123)	(0.152)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Banking group FE	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	233,212	218,232	233,212	218,232	233,212	218,232	233,212	218,232	233,212	218,232
R-squared	0.49	0.51	0.49	0.51	0.49	0.51	0.49	0.51	0.49	0.51
Prob > F	0.011	<0.001	0.031	<0.001	0.037	<0.001	0.004	<0.001	0.034	<0.001

Table 6
Change in short-term lending after the liquidity shock

This table reports results of regressions where the dependent variable is the difference of the log of short-term credit exposure between 2009Q4 and 2007Q2 for each bank-firm in the sample. Short-term credit exposures are exposures with a maturity of less than one year. The explanatory variables of interest are the deposits to assets, stable funding to assets computed as deposits plus financing over 1 year divided by total assets, long term loans to assets computed as loans with maturity over 1 year to total assets, loan to deposits computed as loans divided by deposits, long-term loans to deposits computed as long-term loans divided by deposits, long-term loans to stable funding computed as long-term loans divided by stable funding. All these variables are measured before the liquidity shock in 2007Q2. Other control variables are bank size computed as the logarithm of banks' total assets in 2007Q2, the capital ratio computed as equity divided by total assets in 2007Q2, the NPL ratio computed as non-performing loans divided by total assets in 2007Q2, the ROA computed as net income divided by total assets in 2007Q2, and the loans to assets computed as loans to non-financial customers divided by total assets in 2007Q2. Standard errors are clustered at the bank level and robust to heteroscedasticity. '***', '**' and '*' indicate statistically significant coefficients, respectively, at the 1, 5 and 10% level.

	Change in short-term lending				
	(1)	(2)	(3)	(4)	(5)
Deposits to assets	0.124				
	(0.098)				
Stable funding to assets		0.056			
		(0.110)			
Loan to deposits			-0.000		
			(0.001)		
Long-term loans to deposits				-0.000	
				(0.001)	
Long-term loans to stable funding					0.030
					(0.090)
Bank size	-0.004	-0.007	-0.008	-0.008	-0.009
	(0.015)	(0.016)	(0.015)	(0.015)	(0.015)
Capital ratio	0.744	0.726	0.776	0.774	0.760
	(0.856)	(0.894)	(0.869)	(0.869)	(0.863)
NPL ratio	-1.663	-0.725	-0.304	-0.317	-0.100
	(2.926)	(2.857)	(2.967)	(2.963)	(2.937)
ROA	-8.625	-10.279	-11.413	-11.420	-12.216
	(6.963)	(7.382)	(7.205)	(7.214)	(7.492)
Loans to assets	-0.069	-0.072	-0.057	-0.056	-0.089
	(0.129)	(0.135)	(0.129)	(0.129)	(0.149)
Constant	0.018	0.086	0.133	0.132	0.146
	(0.322)	(0.327)	(0.317)	(0.317)	(0.313)
Firm FE	Yes	Yes	Yes	Yes	Yes
Banking group FE	Yes	Yes	Yes	Yes	Yes
Observations	70,535	70,535	70,535	70,535	70,535
R-squared	0.72	0.72	0.72	0.72	0.72
Prob > F	0.001	0.001	0.001	0.001	0.001

Table 7
Size of the borrower and change in long term lending

This table reports results of regressions where the dependent variable is the difference of the log of long-term credit exposure between 2009Q4 and 2007Q2 for each bank-firm in the sample. Long-term credit exposures are exposures with a maturity of one year or greater. The explanatory variables of interest are stable funding to assets computed as deposits plus financing over 1 year divided by total assets and long-term loans to stable funding computed as long-term loans divided by stable funding. Both variables are measured before the liquidity shock in 2007Q2. Other control variables are bank size computed as the logarithm of banks' total assets in 2007Q2, the capital ratio computed as equity divided by total assets in 2007Q2, the NPL ratio computed as non-performing loans divided by total assets in 2007Q2, the ROA computed as net income divided by total assets in 2007Q2, and the loans to assets computed as loans to non-financial customers divided by total assets in 2007Q2. The full sample of borrowers is divided in three subsamples based on the size of the borrowers. Small firms are firms with a turnover below EUR 1 million in 2007Q2. Medium firms are firms with a turnover between EUR 1 and 100 million in 2007Q2. Large firms are firms with a turnover above EUR 100 million in 2007Q2. Standard errors are clustered at the bank level and robust to heteroscedasticity. '***', '**' and '*' indicate statistically significant coefficients, respectively, at the 1, 5 and 10% level.

	Change in long-term lending					
	Small firms		Medium firms		Large firms	
	(1)	(2)	(3)	(4)	(5)	(6)
Stable funding to assets	0.154***		-0.100		-0.236	
	(0.049)		(0.077)		(0.244)	
Long-term loans to stable funding		-0.128***		-0.118		-0.111
		(0.040)		(0.078)		(0.163)
Bank size	0.011	0.001	0.003	0.005	0.116**	0.123***
	(0.007)	(0.007)	(0.014)	(0.014)	(0.045)	(0.042)
Capital ratio	-0.376	-0.376	1.330*	1.282*	-1.711	-1.028
	(0.467)	(0.470)	(0.762)	(0.768)	(1.798)	(2.072)
NPL ratio	-1.442	-0.995	0.772	-0.408	-3.744	-6.785
	(1.679)	(1.597)	(2.789)	(3.047)	(9.344)	(9.612)
ROA	9.159**	9.319**	-5.997	-0.177	10.475	18.469
	(3.728)	(3.674)	(5.693)	(5.657)	(18.460)	(16.642)
Loans to assets	-0.019	0.077	0.183	0.241*	1.133***	1.098***
	(0.065)	(0.062)	(0.128)	(0.130)	(0.326)	(0.342)
Constant	-0.314*	-0.018	-0.413	-0.463	-2.207**	-2.440***
	(0.163)	(0.153)	(0.320)	(0.331)	(1.022)	(0.905)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Banking group FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	161,790	161,790	54,317	54,317	2,125	2,125
R-squared	0.45	0.45	0.60	0.60	0.52	0.52
Prob > F	<0.001	<0.001	0.006	0.002	<0.001	<0.001

Débats Économiques et Financiers

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