Credit Growth and Bank Capital Requirements: Binding or Not?*

Claire Labonne[†], Gildas Lamé[‡]

July 2014

Abstract

This paper examines the sensitivity of non-financial corporate lending to banks' capital ratio and their supervisory capital requirements. We use a unique database for the French banking sector between 2003 and 2011 combining confidential bank-level Bank Lending Survey answers with the discretionary capital requirements set by the supervisory authority. We find that on average, more capital means an acceleration of credit. But the elasticity of lending to capital depends on the intensity of the supervisory capital constraint. More supervisory capital-constrained banks tend to have a credit growth that is less responsive to the capital ratio. Our results also show a similar effect for non-performing loans. When banks are constrained, credit growth is all the more sensitive to this type of assets as their share rises. However, both aforementioned effects weaken close to the supervisory minimum capital requirement.

Keywords: Bank Lending, Bank Regulation, Capital
JEL classification: G21, G28, G32

*This paper was previously circulated under the title "Credit Growth and Bank Capital Requirements in the French Banking Sector". We thank Jean-Baptiste Bernard, Guillaume Cléaud and Jean-Baptiste Haquin for their valuable support and Farida Azzi for excellent research assistance. We also thank José Bardaji, François-Daniel Castellani, Éric Dubois, Henri Fraisse, Mathias Lé, Matthieu Lequien, Jean-Stéphane Mésonnier, Henri Pagès, Aurélien Poissonnier, Corinne Prost and Jan Riepe for their comments. We would like to especially thank Vincent Bouvatier, Andrea Nobili for their fruitful discussions. The views expressed are those of the authors and do not necessarily reflect those of the Autorité de Contrôle Prudentiel et de Résolution, Banque de France or INSEE.
†Autorité de Contrôle Prudentiel et de Résolution, Banque de France, 61 rue Taitbout, 75009 Paris, claire.labonne@acpr.banque-france.fr
‡French Ministry of Finance, 139 rue de Bercy 75572 Paris Cedex 12, gildas.lame@dgtresor.gouv.fr

1 Introduction

80% of non-financial corporations (NFCs) funding depends on banks in France, to be compared with only a third for the United States (Paris Europlace (2013)), which explains why banks are a crucial element for French firms to make the investments essential to their businesses. The health of the banking sector has been and is under close scrutiny, as exemplified by the Asset Quality Review the European Central Bank and national supervisory authorities are undertaking in 2014.

The evolution of banking regulation spurred by the Third Basel Accord in 2011 and its transposition into European and French law in 2013 triggered a debate over the impact on the real economy. The main policy instrument in the supervisory toolbox is capital ratios. The amount and quality of capital required for micro-prudential purposes has been increased through core equity Tier 1 ratios or the capital conservation buffer for example. Macro-prudential requirements, such as the countercyclical capital buffer, G-SIFIs requirements or the systemic risk buffer even increase the weight of the supervisory constraints.

If banks have to fulfill these capital requirements and manage their balance-sheet accordingly, this could induce them to reshuffle their investments. Some market segments could be privileged over others, depending on their capital costs. The central question of the current debate is then: how do banks adjust their lending in response to fluctuations in their capital-to-assets ratios? The answer to the question is not straightforward. The elasticity of lending to capital depends on capital costs relative to other sources of funding as well as investor's risk aversions or their returns expectations (see Admati and Hellwig (2013)).

We propose to participate to this debate by making use of a unique database for the French banking sector between 2003 and 2011 combining bank-level Bank Lending Survey (BLS henceforth) answers with the discretionary capital requirements set by the French Prudential Supervisory and Resolution Authority. Thanks to this database, we can estimate the impact of additional capital (measured by the bank's Tier 1 capital-to-assets ratio) on quarterly credit growth and qualify it with respect to the intensity of the supervisory capital constraint.

We find that on average, in our sample of French banks, more capital means an acceleration of credit. But the elasticity of lending to capital depends on the intensity of the supervisory capital constraint. More supervisory capital-constrained banks' credit growth tend to be less responsive to a higher capital ratio than unconstrained banks. We thus show that making the supervisory constraint bind induces banks to slow their production of loans. We also find that more supervisory capital-constrained banks tend to be more reactive to the ratio of non-performing loans than unconstrained banks. The former are more prone to reduce credit allocation after a rise in these problematic assets than the latter. However, both aforementioned non-linear effects seem to weaken as banks get close or below their supervisory minimum capital requirement.

The remainder of the paper is organized as follows. The next section briefly reviews the literature related to our analysis. Section 3 presents a summary of the theory surrounding bank capital and lending. Section 4 takes a look at the data used, which comprise detailed bank-level BLS survey responses as well as individual fine-tuned capital requirements set by the banking supervisor in France. In section 5, we outline our methodology for estimating the link between banks' capital ratio and lending. Section 6 reports our empirical findings and section 7 concludes.

2 Related literature

The literature has been intensively examining the effects of capital on lending since the first regulations were defined with Basel I in 1988. But the question has never been under such spotlight before the financial crisis triggered a worldwide regulatory response. From an empirical perspective, the literature has tackled three essential issues. First of all, uncovering the potential effect of capital requires disentangling supply effects from demand effects on bank lending. Secondly, a clear distinction must be made between the various possible capital ratios (regulatory ratio or non-weighted, absolute level or relative level compared to a target for example). Thirdly, the relationship between bank lending and capital might not be linear. In this section, we review these essential issues for our question.

2.1 Disentangling loan supply from loan demand

The most problematic issue for isolating the effect of capital on lending is to control for changes in loan demand. Several approaches have been used in the literature, the most common one being to explicitly take into account economic conditions directly linked to loan demand such as GDP growth or similar macroeconomic variables (see for example Gambacorta and Mistrulli (2004) or Berrospide and Edge (2010)). Other papers use regional variations of bank health and economic conditions to disentangle supply from demand effects. Bernanke et al. (1991) use simple reduced-form loan equations to detect the effect of capital on lending during the credit crunch that took place in New England in 1990. A third solution consists in taking advantage of a natural event that resulted in a shock to banks' capital base without any changes in loan demand. These studies typically focus on multinational banking groups which go through a shock to one of its foreign branches (such in Peek and Rosengren (2000)) and see how the supply shock in the foreign country affect lending in the home country of the bank.

Finally, several papers tackle the disentangling issue with questions extracted from national bank lending surveys. In the case of the US Senior Loan Officer Opinion Survey (SLOOS), several papers use the aggregated responses of banks on their standards to study the effect of credit supply on the fluctuations of the US economy such as Lown et al. (2000), Lown and Morgan (2006) and Ciccarelli et al. (2010) among others. Most of them build on standard monetary VARs that include these survey responses to better control for supply-side effects but they do not explicitly focus on the impact of bank capital. The Eurozone, with its own Bank Lending Survey (BLS) which started in 2002Q4, also contributes to the literature. Works that make use of the aggregate survey data circumvent the limited size of the sample by working on area-wide panels such as Ciccarelli et al. (2010) or Hempell and Sørensen (2010). In the literature, only a few papers have taken advantage of the bank-level BLS data. Blaes (2011), Del Giovane et al. (2011) and Bassett et al. (2014) for instance all use bank-level credit data combined with individual responses to the lending survey to study the dynamics of credit in Germany, Italy and the US respectively. So far, the literature has revealed the significant contribution of these bank lending surveys to identify credit supply shocks especially during the financial crisis. For example, Del Giovane et al. (2011) find that supply factors such as banks' balance sheet position or their perception of credit risk had a significant contribution though relatively minor on the fall of bank lending in Italy during the 2007-2009 financial crisis.

2.2 Observed capital ratios and regulatory capital requirements

In general, one would presume that the minimum capital requirements affect banks' observed capital ratios and subsequently lending. This issue has been studied in the past in the regulation impact analysis literature. Aiyar et al. (2014) test if changes in capital requirements affect loan supply by regulated banks and whether unregulated substitute sources of credit are able to offset changes in credit supply by affected banks. They use time-varying bank-specific minimum capital requirements imposed by UK regulators. They find that regulated banks decrease lending in response to tighter capital requirements on a relevant reference group of regulated banks. Francis and Osborne (2012) find that capital requirements affect banks' desired capital ratio. They show that the potential gap between the actual and desired ratio have significant consequences on bank lending. More recently, Brun et al. (2013) analyze the consequences of capital requirements on bank lending using loan-level data and the transition from Basel I to Basel II. They find a strong negative effect of capital requirements on lending.

Some papers also focused on observed capital ratios and find a positive relationship between capital and lending. Berrospide and Edge (2010), Carlson et al. (2013) among others use bank-level data to estimate the impact of capital on lending and find small positive effects on credit dynamics (see table 1 for more detailed quantitative results on the impact of bank capital fluctuations on lending). The qualitative side of these results are in line with the theoretical features uncovered by Repullo and Suarez (2013) who show banks under any regulatory regimes will still hold positive capital buffer in order to preserve their future lending capacity. However, the elasticity found in the literature greatly varies as showed in table 1. This heterogeneity could come from non-linear effects between capital and lending.

Paper	Effect of a 1-ppt shock to:	Dependent variable	Impact (ppt)
Bernanke and Lown (1991)	Bank capital ratio	Bank lending growth (US)	+2-3
Berrospide and Edge (2010)	Bank capital-to-assets ratio	BHC loan growth (US)	+0.145
Carlsson et al (2013)	Total capital-to-assets ratio	Bank lending growth (US)	+0.13-2
Francis and Osborne (2012)	Surplus bank capital ratio	Bank lending growth (real sector UK)	+0.060
Gambacorta and Mistrulli (2004)	Excess regulatory capital-to-assets ratio	Bank and credit cooperatives lending growth (Italy)	+0.744

Table 1: Estimations of the impact of observed capital ratio on lending growth

2.3 Non-linear effects between capital and lending

The link between capital and lending seems to be non-linear according to recent empirical research. Jiménez et al. (2012) find highly capitalized banks are less prone to lend to new borrowers but the sign is reversed if interactions with macroeconomic variables are considered in the regression. Carlson et al. (2013) show the capital ratio has a more significant impact on lending when it is already low than when it is high. The significance also depends on the type of loans considered. These results corroborate those found by Albertazzi and Marchetti (2010) in the case of Italy during the 2008-2009 financial crisis. Only very low-capitalized banks (less than 10% RWA) cut lending; in addition apart from bank-specific factors, firm-specific characteristics (such as size, riskiness) are essential determinants too. In the same vein, di Patti et al. (2012) study the transmission of shocks to banks balance sheets to their loan portfolio. A deterioration of banks' capital position had a significant negative impact on lending during the Lehman crisis. They argue a higher capital ratio positively influences lending indirectly through its interaction with asset quality and the funding structure so that there's not a straight linear relationship between these two variables of interest.

3 Capital and Credit Supply: Insights from Theory

Why and how would equity capital (capital in general by extension) impact credit growth? It depends both on the rationale for holding capital and on capital market characteristics.

3.1 Economic and Regulatory Capital

Banks hold capital because either they think it is optimal (economic capital) or because supervisors or the market want them to do so (regulatory capital). Equity capital represents the part of unborrowed funds available for a bank that can be used to finance its investments. The amount of capital is determined by bankers under the framework of their portfolio management strategy. This 'voluntarily held' equity does not have an obvious impact on credit growth. Increasing equity in absolute terms allows the expansion of the balance sheet, so it can result in higher credit supply, *ceteris paribus*. If the banker increases its ratio of equity to assets, it may be to fit its funding mix to new asset classes, especially their liquidity and maturity characteristics. So it can be associated with an increase for some credit categories and a decrease for others.

When equity capital stems from the banker's optimization problem, its impact depends on the production function and risk aversion of the bank. But external constraints, due either to the supervisor or market forces, disrupts the asset allocation desired by the bank. If the capital level is not already high enough to fulfill the requirements, the bank has to raise equity. However, providing equity may be more costly than other forms of funding. As a consequence, banks would attempt to shrink the size of their balance sheet, hence the amount of assets and certainly credit if all asset classes are affected uniformly.

Thus, regulatory capital could shrink credit growth while economic capital has an uncertain effect on the latter. The size and direction of these effects depend on two conditions: the relevancy of the capital structure and the specificity of capital as a funding instrument (see table 2).

3.2 Modigliani-Miller Propositions

The Proposition I of Modigliani-Miller (M&M henceforth, Modigliani and Miller (1958)) states the irrelevance of the capital structure on the value of the firm and on its funding cost while Proposition II shows that equity cost rises with leverage. However, M&M has been a hotly-debated issue among academics and bankers alike on its application in the banking sector in contrast with other industries. If M&M applies in the case of banks, the share of equity in the funding mix should not be a source of concern for credit growth. Miller (1995) answers whether the M&M's propositions apply to banks and he replies with a very short abstract: "Yes and no.", thus emphasizing the complexity of the question.

Indeed, Proposition I theoretically holds with no taxation and no market imperfections. But banks' existence is the very result of information asymmetries (between the lender and the borrower) and they suffer themselves from agency issues (between the shareholder and the manager, see Dewatripont and Tirole (1994)). Moreover, deposit insurance and taxation also create distortions. All these elements entail the failure of M&M's Proposition I about the irrelevancy of capital structure. In such situations, funding costs may then depend on the funding mix because tax rules that favor debt over equity prevail for example. When both propositions fail, a bank can leverage up without equity being more costly. In this case, switching to a higher share of equity in the capital structure would deprive the bank of cheaper financing such as deposits or wholesale funding and it would most likely lead it to cut credit.

However, a more realistic framework would not necessarily entail the failure of Proposition II, which states that, with or without taxes, equity costs rise with leverage as risk in the bank would increase and investors would want to be adequately compensated for the riskiness of their potential investments in the bank.[1] So raising the equity share of the capital structure would decrease its marginal cost, offsetting a part of the structural higher cost of equity financing. In such setting, the impact of more capital on credit is not clear-cut. Table 2 sums up the possible outcomes of a higher capital ratio on bank credit growth under different assumptions regarding the validity of M&M's propositions.

		M&M's Proposition II	
		Holds	**Fails**
M&M's Proposition I :	**Holds**	Irrelevant	
	Fails	+/-	-

Table 2: Theoretical effect of a higher share of equity capital on lending

The paper tries to uncover the variations induced by the level of capital in general on lending growth while taking into account the binding or non-binding aspect of capital constraint.

4 Data

4.1 Balance-sheet data

We extract balance-sheet data from banks' quarterly reports to the French Prudential Supervisory and Resolution Authority. Overall, our sample represents around 64% of all bank assets (see appendix A.1). Table 3 shows some summary statistics of the explaining variables used in the sections of this paper. It shows that the average actual Tier 1 capital-to-assets ratio ($CAT1$) in our sample is quite high at 6%. The average ratio of non-performing loans (NPL) is low.

Our main variable of interest is credit granted to NFCs. More precisely, we consider the sum of every credit type granted to NFCs: liquidity, export, housing, commercial, equipment, account receivable. As it is usually done in the banking sector, only credit outstanding amounts are reported. Due to the length of loan contracts, the reported amounts can be the outcome of deals made many periods before. To remove part of this inertia and in order to get closer to new credit activity (which is believed to be influenced by banks' capital position), we actually consider the quarterly growth rate of credit granted to NFCs in the rest of our paper.[2] According to table

[1] See Admati and Hellwig (2013) for a discussion.

[2] We argue this approach allows to get closer to credit activity during the period observed, though it is still plagued by the well-known shortcoming that changes in loan stocks also reflect write-offs, exchange-rate effects, reporting changes etc.

	N	mean	sd	min	max
QoQ_NFCloans	386	0.021	0.086	-0.378	0.651
CAT1	386	0.059	0.029	0.015	0.172
NPL	386	0.020	0.021	0.001	0.135

Table 3: Summary statistics of bank variables. Outlier observations that do not correspond to mergers and acquisitions (M&A) operations are excluded.

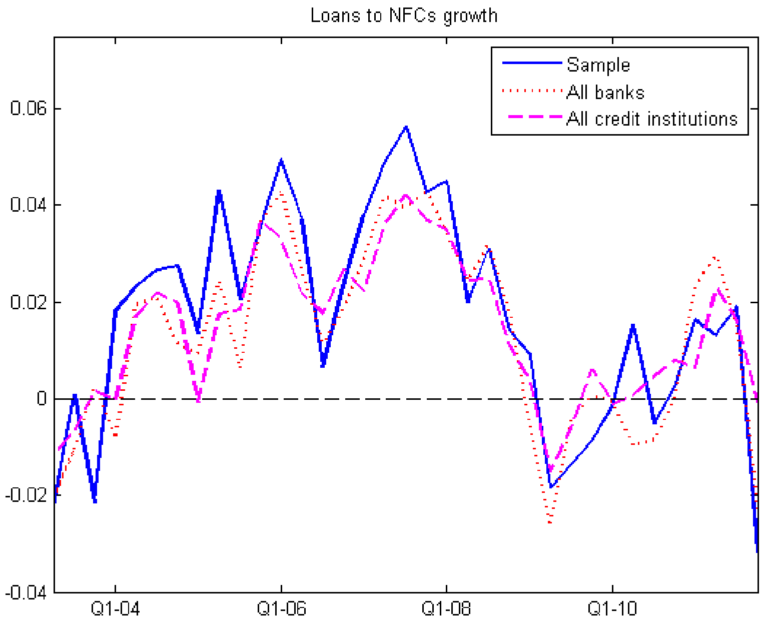

Figure 1: Quarterly growth of rate of loans to NFCs for our total sample (blue solid line), the aggregate French banking sector (red dotted line) and all credit institutions in France (pink dashed line).

3, NFCs credit growth ($QoQ\_NFCloans$) displays significant volatility across both the time and cross-sectional dimensions.

As shown in figure 1, NFCs credit growth has been quite dynamic in France for the past few years. It broadly accelerated until the crisis burst. After a peak at the end of 2007, credit growth began to significantly slow until contracting in the first half of 2009. Despite a short economic recovery following the trough in 2008-2009, NFCs credit dynamics became subdued again as the European sovereign debt crisis began to take hold in the core countries of the Euro area. Then, two years after the first credit crunch, we observe a contraction in loans granted to NFCs when problems in other parts of the Eurozone developed again. Regarding the representativeness of our sample (see section 4.2), notice that the aggregate credit dynamics of our sample closely follows the banking sector's as well as all credit institutions'.

4.2 Bank Lending Survey data

The European Central Bank has been conducting the Bank Lending Survey (BLS) since 2002Q4 actually.[3] It consists in a set of questions with categorical answers filled every quarter by individual banks in the Euro area.[4] The survey provides information on the supply and demand conditions they face, by loans and counterparty types. The banks' sample for each country is chosen by the national central bank to get representative information on developments in credit standards, non-interest rate credit conditions and terms, risk perception of banks and the willingness of banks to lend with both a backward- and forward-looking perspective. For our empirical assessment, we restrict the sample to a panel of 13 banks, queried in the survey from 2003Q1 to 2011Q4.[5]

Table 4 presents detailed statistics on the main responses on standards given by French banks

[3] The Bank Lending Survey sampling and time period coverage defines our own sample. We did not have access to the data corresponding to 2002Q4. The period 2003-2011 is characterized by both the transition from Basel I to Basel II and the crisis period. These structural breaks are tested in an econometric framework.

[4] See Berg et al. (2005) for a complete description.

[5] Three banks in our sample stopped being questioned a few quarters before 2011Q4 for the BLS.

in the BLS. Similar to the features found in the BLS results for other Euro-area countries (Del Giovane et al. (2011) for Italy or Blaes (2011) for Germany), French banks' answers do not often differ from the recurrent "basically unchanged". We also notice the fifth categorical response is almost non-existant.

Figure 2a plots a balance of opinion on the question about the evolution of credit standards for the past quarter applied on loans to NFCs (computed as the sum of banks declaring to have tightened their standards minus the ones declaring to have eased). As shown in the figure, French banks tightened their credit standards to non-financial corporates three times in the past (2003, 2008-2009 and 2011H2). Turning to perceived credit demand by NFCs reported by French banks displayed in figure 3a, it seems to have continuously increased until Lehman bankruptcy. At the end of 2011, it appears that credit demand from NFCs was still weak compared to historical standards.

(a) Balance of opinions - NFCs credit standards

(b) Cumulative BLS indicator

Figure 2: BLS questions on credit standards for France

(a) Balance of opinions - NFCs credit demand

(b) Cumulative BLS indicator

Figure 3: BLS questions on credit demand for France

Responses 2003Q1-2011Q4	1="Tightened / decreased considerably"	2="Tightened / decreased somewhat"	3="Remained basically unchanged"	4="Eased / increased somewhat"	5="Eased / increased considerably"	Total observations
NFCs credit standards	12	50	373	23	0	458
	2.62%	10.92%	81.44%	5.02%	0%	100%
Mortgage credit standards	0	19	426	13	0	458
	0%	4.15%	93.02%	2.84%	0%	100%
NFCs credit demand	9	91	322	36	0	458
	1.97%	19.87%	70.30%	7.86%	0%	100%
Mortgage credit demand	13	68	263	86	28	458
	2.84%	14.85%	57.43%	18.78%	6.11%	100%

Table 4: Detailed statistics on the banks' responses to the general questions on credit standards and demand regarding loans to NFCs and mortgage loans. The number of responses per category is listed as well as their frequency.

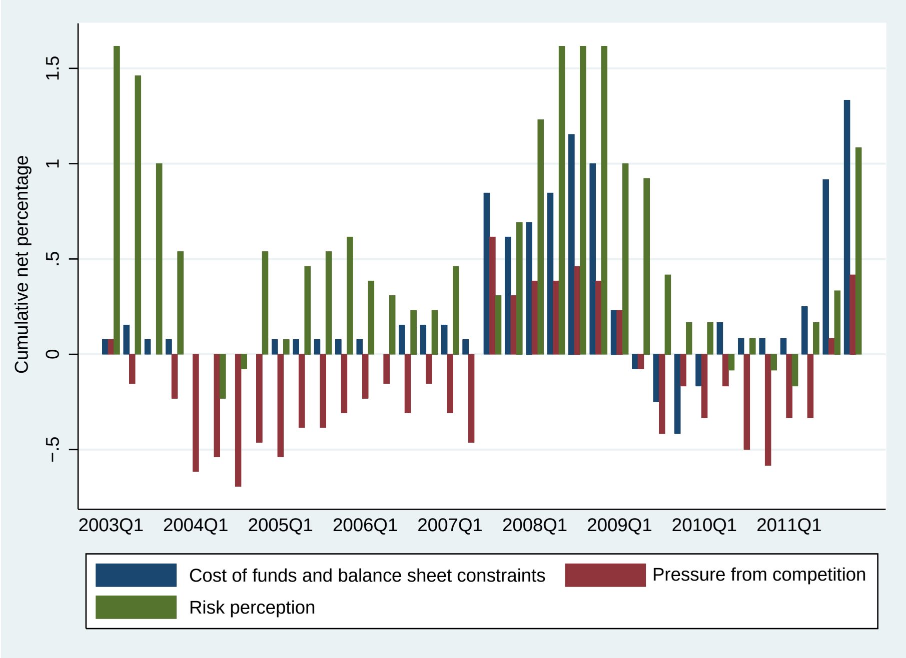

Figure 4: Balance of opinions on the question of credit standards applied to loans to NFC during the past quarter.

Figure 4 shows how the different underlying factors behind the change in credit standards for loans to NFCs varied over time.[6] At first sight, the risk perception by French banks was the main reason that led them to tighten their standards for loans to NFCs in all these restrictive periods of credit distribution, though it is worth noticing that the cost of funds and balance-sheet constraints also impacted the banks' decisions during the Great Recession and more recently in the midst of the European sovereign debt crisis.

Van der Veer and Hoeberichts (2013) warn about an issue about the survey data, namely whether respondents answer literally or not to the questions. The way we just interpreted the results of the survey implies banks do not literally respond to the BLS question but instead, report the "degree of tightness" at one point in time in the case of lending standards for example. The same would go for credit demand. As it is often done in the literature, we can construct the following BLS-related variables:

$$BLS\_S_{i,t} = \begin{cases} -1 \text{ if bank } i \text{ reported easing standards on loans to NFCs in quarter t} \\ 0 \text{ if bank } i \text{ reported no change in standards on loans to NFCs in quarter t} \\ 1 \text{ if bank } i \text{ reported tightening standards on loans to NFCs in quarter t} \end{cases}$$

$$BLS\_D_{i,t} = \begin{cases} -1 \text{ if bank } i \text{ reported decreased demand for loans to NFCs in quarter t} \\ 0 \text{ if bank } i \text{ reported no change in demand for loans to NFCs in quarter t} \\ 1 \text{ if bank } i \text{ reported increased demand for loans to NFCs in quarter t} \end{cases}$$

The balances of opinion presented in figure 2a and 3a are simply deduced from $BLS\_S_{i,t}$ and $BLS\_D_{i,t}$. Instead of using these two variables and by extension a simple balance of opinion,

[6]Cumulative net percentages for the underlying factors of bank credit standards represent for the determinant summarized as "Cost of funds and balance-sheet constraints" the sum of the net percentages for the factors "costs related to the bank's capital position", "bank's ability to access market financing" and "bank's liquidity position" for example.

Van der Veer and Hoeberichts (2013) suggest to stick to the literal reading of the questions and construct cumulative BLS indicators, which are then supposed to reflect the "true" level of tightness of lending standards implied by the survey. These cumulative indicators are constructed as follows:

$$Cumu\_BLS\_S_{i,t} = \begin{cases} 0 & if\ t = 2003Q1 \\ Cumu\_BLS\_S_{i,t-1} + 1 & if\ t > 2003Q1 \text{ and lending standards at } t \text{ are "tightened"} \\ Cumu\_BLS\_S_{i,t-1} + 0 & if\ t > 2003Q1 \text{ and lending standards at } t \text{ are "unchanged"} \\ Cumu\_BLS\_S_{i,t-1} - 1 & if\ t > 2003Q1 \text{ and lending standards at } t \text{ are "eased"} \end{cases}$$

$$Cumu\_BLS\_D_{i,t} = \begin{cases} 0 & if\ t = 2003Q1 \\ Cumu\_BLS\_D_{i,t-1} + 1 & if\ t > 2003Q1 \text{and credit demand at } t \text{ "increases"} \\ Cumu\_BLS\_D_{i,t-1} + 0 & if\ t > 2003Q1 \text{and lending standards at } t \text{ is "unchanged"} \\ Cumu\_BLS\_D_{i,t-1} - 1 & if\ t > 2003Q1 \text{and lending standards at } t \text{ "decreases"} \end{cases}$$

As shown in figure 2b, the "true" level of tightness in credit standards to NFCs has significantly increased, especially since the end of 2007. Notice that the pre-2007 period saw relaxed standards coinciding with growing credit distribution in France (see figure 1). After the peak of the financial crisis, conditions eased briefly before rekindling again with the European sovereign debt crisis. Turning to the credit demand by French NFCs, figure 3b points to a loan demand that has been decreasing ever since the inception of the survey. As expected, the financial crisis of 2008-2009 dealt a significant blow, pushing it to a new trough. The European sovereign debt crisis made the situation tense again at the end of our sample. Again, this evolution broadly concurs with NFCs credit dynamics (see figure 1). Overall, the message carried by the cumulative indicators is slightly different from the one presented in figure 2a and 3a but both are informative and relevant in the assessment of the credit market.

Van der Veer and Hoeberichts (2013) argue the cumulative indicators are better determinants of bank credit dynamics. From a practical viewpoint, $Cumu\_BLS\_S_{i,t}$ ($Cumu\_BLS\_D_{i,t}$ respectively) has the advantage of being non-categorical, in contrast with $BLS\_S_{i,t}$ ($BLS\_D_{i,t}$ respectively) which might lead to less precise estimates of the coefficients given the small size of our sample. They find for the Netherlands an economically significant negative effect of the level of standards on credit growth. Del Giovane et al. (2011) in the case of Italian banks test both the standard and cumulated indicators and conclude the former is more relevant in explaining credit dynamics. Given the negative dynamics of $Cumu\_BLS\_D_{i,t}$ and the positive one of bank credit over most of the sample period in France, using $Cumu\_BLS\_D_{i,t}$ might lead us to the wrong conclusion that demand is negatively correlated with credit growth for example. This apparently suggests that the banks' assessments on demand should be interpreted in terms of "acceleration" and "deceleration", rather than "increase" and "decrease". Thus, from now on, we will instead only consider $BLS\_S_{i,t}$ and $BLS\_D_{i,t}$ in the rest of the paper.

4.3 Capital requirements

Pillar I of the Basel II accord requires banks to maintain at all times a minimum of Tier 1 capital equal to 4% of risk-weighted assets (RWA). The second Pillar provides a framework for the supervisor to determine the soundness of a bank. Based on a thorough assessment of the institution's activities and risk profile, the supervisor can require the bank to hold a higher level of capital than the minimum legal requirement of Pillar I. This additional buffer, determined each year at the French banking supervisor's discretion, constitutes the key variable of interest in our paper. Notice that the French banking supervisor has been making use of this strategy well before the official implementation of Basel II in France.

The average total regulatory requirement (regarding Tier 1 capital) between 2003 and 2012 for our banks sample has been above the legal minimum of 4%. For the period 2003-2006, the additional requirement was more or less stable. It increased during the following years until reaching in 2010 a peak. These supervisory requirements vary in the cross-sectional dimension but vary only gradually through time for a given bank.

The difference between the observed ratio and individual total discretionary requirements[7] is on average strictly positive. Actually, some banks even have an effective solvency ratio way above the supervisor's requirement. Since 2009, whereas supervisory requirements are increasing, buffers are on average bigger than their beginning of period level. This may denote market discipline pressure.

For the sample gathered here, banks with a solvency ratio below the supervisory requirement are an exception. Concluding that the supervisor has no efficient pressure here on banks would be missing the point. Such a strict definition does not account for potential anticipations. Repullo and Suarez (2013) show that banks may even prefer benefit from a buffer above regulatory requirements so as to be able to lend as much as desired in the subsequent periods. Maintaining a buffer just enough to be above the supervisor's requirement might reflect continuous supervisor's pressure as well as the bank's internally desired path of conduct.

4.4 Macroeconomic data

To take into account aggregate demand, we consider the quarterly growth of nominal investment by NFCs (*d_Investment*). *Eonia* will be considered to control for monetary policy.

5 Methodology

5.1 Reduced Form Equation

We want to estimate the impact of a variation in the capital ratio on the growth rate of NFCs loans. Ideally, we would estimate a credit supply equation. However, we cannot ignore the simultaneity bias the estimation would suffer from. Therefore, we turn to the BLS survey to find a demand shifter and introduce a reduced form equation in which the parameter of interest is the coefficient β that follows:

$$\Delta y_{i,t} = \alpha + \beta(L)CAT1_{i,t} + \gamma(L)X_{i,t} + \mu_i + \lambda_t + q_t + \varepsilon_{i,t}$$

$\Delta y_{i,t}$ denotes the quarterly growth rate of credit to NFCs granted by bank i between quarter t and $t-1$. The variable is the sum of every credit type granted to NFCs: liquidity, export, housing, commercial, equipment, account receivable.

[7] Here, we consider as capital buffer the difference between economic capital and the supervisor requirement. This is not the difference between economic capital at date t and the bank internal target capital, as tackled in dynamic capital ratio models (see Francis and Osborne (2012) for an example).

We consider the prudential definition of funds for solvency purposes. The variable of interest is the amount of eligible Tier 1 Capital (namely "original own funds"). This is the sum of eligible capital, eligible reserves and funds for general banking risks.[8] $CAT1$ is the ratio of this quantity to total assets.[9] To correct for the endogeneity bias due to accounting relationships between the asset and the liability sides of the balance sheet, we consider the first lag of $CAT1$.[10]

$X_{i,t}$ denotes a set of control variables. At the bank level, we include the BLS categorical variables about credit standards ($BLS\_S_{i,t}$) and demand ($BLS\_D_{i,t}$). Non-performing loans (NPL) are also included to control for bank risk. At the macroeconomic level, we control for economic activity with NFCs quarterly nominal investment growth ($d\_Investment$) and monetary policy ($Eonia$). λ_t is a time dummy, q_t a seasonal dummy and μ_i a bank fixed effect.

5.2 Capital and Capital Requirements

In order to test for the non-linearity induced by supervisory capital requirements in the relationship between capital and credit growth, we use the following variable:

$$Buffer_{i,t} = bank\_ratio_{i,t} - supervisor\_requirements_{i,t}$$

where $supervisor\_requirements$ stands for the individual Pillar II total discretionary capital requirement required by the supervisor and $bank\_ratio_{i,t}$ the ratio effectively reached by the bank on a consolidated basis,[11] below or above the total supervisory requirement. By doing so, we implicitly assume that the larger the difference between economic and required capital, the looser the supervisory constraint. This assumption could be violated if banks anticipate Basel III so that the true constraint is not what is required at date t by the supervisor and/or the market but what she will require at date $t+i$. We are confident our sample does not suffer from this bias. Indeed, we can date the official supervisory emphasis on Basel III rules from September 2011 when the EBA (European Banking Authority) announced the objective of 9% of CET1 capital in June 2012. This affects only the last observation of our sample. Moreover, the first proposal for Basel III happened to be published only in 2010Q3. Even if we suppose French banks started to anticipate the future implementation of the new package at the end of 2010, this would only affect a negligible part of our sample.

By analyzing bank supervisor's reports on the Pillar II surcharge, it seems the French Prudential and Resolution Authority tends to favor a minimum 50-bp buffer, meaning a lower level is almost equivalent to no buffer at all for supervisors. Using this judgmental criterion, we thus single out this 50-bp threshold for $Buffer_{i,t}$ above which banks might be less constrained by the supervisor. Combining this qualitative and quantitative threshold with $Max(Buffer_{i,t})$, we split the distribution of $Buffer_{i,t}$ along three segments, two of which, above 50 bps, are of identical

[8] See http://www.eba.europa.eu/Supervisory-Reporting/COREP/COREP-framework.aspx for details.

[9] Thus, we consider a prudential leverage ratio and not a risk-weighted solvency ratio. Since we run regressions from 2003 to 2011, the definition of RWA is not constant throughout the period. We could reproduce *a posteriori* what would have been RWA before Basel II by computing the Basel formula on bank's portfolio data. We do not consider this approach due to two caveats. First, and most importantly, this requires assuming bankers' behavior is immune to the risk weighting of solvency ratios, since they would not have adapted to the regulatory context. We proxy the risk profile of the balance-sheet by the ratio of non-performing loans to total loans granted (NPL). Second, data are not granular enough to build consistent estimates.

[10] This standard technique in the banking literature may be weakened for highly autocorrelated variables. But it is not the case here. Moreover, we divide the amount of eligible Tier 1 capital by total assets whereas we only try to explain the growth of a particular item of the balance sheet, namely credit to NFCs (representing on average 10% of total assets). As the bank portfolio is re-optimized at each period, this makes the endogeneity issue less stringent.

[11] We therefore assume that the consolidated-level constraint affects each institution of the banking group uniformly.

lengths. Doing so, we can define three dummy variables for each observation being in a given segment, which will constitute the basis for three different groups of banks. Precisely, we build, with s_i the point defining the cut-off point between the i^{th} and $i+1^{th}$ segment,[12] the three following groups of banks:

$$Group\_A_{i,t} = \begin{cases} 1 & \text{if } Buffer_{i,t} \leq s_1 = 50bps \\ 0 & \text{otherwise} \end{cases}$$

$$Group\_B_{i,t} = \begin{cases} 1 & \text{if } s_1 < Buffer_{i,t} \leq s_2 = \frac{s_1+Max}{2} \\ 0 & \text{otherwise} \end{cases}$$

$$Group\_C_{i,t} = \begin{cases} 1 & \text{if } s_2 < Buffer_{i,t} \\ 0 & \text{otherwise} \end{cases}$$

We also build the interactions between these dummies and $CAT1$. Doing so, we can augment our baseline specification and estimate $(\beta_j)_{j=1,2,3}$ in :

$$\begin{aligned} \Delta y_{it} = \quad & \alpha + \beta_0(L)CAT1_{i,t} \\ & +\beta_1(L)[CAT1_{i,t} \cdot Group\_A_{i,t}] + \beta_2(L)[CAT1_{i,t} \cdot Group\_B_{i,t}] + \beta_3(L)[CAT1_{i,t} \cdot Group\_C_{i,t}] \\ & +\beta_4(L)Group\_A_{i,t} + \beta_5(L)Group\_B_{i,t} + \beta_6(L)Group\_C_{i,t} \\ & +\gamma(L)X_{i,t} + \mu_i + \lambda_t + q_t + \varepsilon^2_{i,t} \end{aligned}$$

The different groups defined above reflect the scale of supervisory constraint faced by banks in the sample. For instance, banks belonging to group A could be qualified as "weakly/undercapitalized" as they barely or do not meet supervisory requirements. Being in this group means these banks will be subject to frequent on-site inspections and prompt corrective actions which will require them to restrict asset growth, submit a capital restoration plan etc. Thus, group-A banks are subject *a priori* to an intense supervisory constraint. Banks belonging to group B may be viewed as "adequately capitalized" and they will be less likely subject to frequent inspections and corrective actions. Finally, banks in group C could be qualified as "well capitalized" as they far exceed the supervisory minimum requirement and therefore enjoy a higher degree of freedom in their activities in contrast with group A. Group C of the distribution of $Buffer$ will be our reference group from now on. We also test analogous specifications with the interactions for NPL, the ratio of non-performing loans to the total amount of loans granted.

5.3 Estimation Method

We estimate the equations with a fixed-effect (μ_i) panel data estimation procedure. We select the lag order of our control variables with the usual BIC criterion. As the Pillar-II capital surcharges are set once a year by the supervisor in France, we posit that the implied supervisory constraint may affect the bank with a lag of a few quarters, which will be determined from the value of the information criterion.

Since the Bank Lending Survey has a sample of institutions selected on a solo basis while prudential equity capital is a group-wide measure, we have to correct for correlation between individuals that are part of the same consolidated entity.[13] We do so by basing inference on a

[12] A slightly lower or higher s_2 does not change our overall results.

[13] For example, teams within a same banking group compete to get the largest capital allocation for their activities.

group-clustered estimator of the variance-covariance matrix (Wooldridge (2003)).[14]

Our panel is unbalanced, because of concentration dynamics in the French banking sector.[15] Bank balance-sheet datasets often contain a significant number of outlier observations reflecting mergers & acquisitions (M&A) or other structural changes in a bank structure or a statistical break. With the help of information provided by the French banking supervisor, we list 32 outlier observations, 7 of them corresponding to M&A operations and the rest to take into account a structural break for one bank in the sample.[16] Moreover, we had to combine bank data originating from two different databases of the French supervisor. Thus, we take this into consideration in our analysis by creating a dummy variable for the aforementioned structural break and that equals 1 at each M&A event or at each period that makes use of a different bank database (Data quality dummy). We also control for a crisis dummy in some of our specifications, which is equal to 1 from 2008q3 onwards.

6 Empirical results

6.1 Capital Requirements and Economic Capital

Table 5 presents our baseline estimation of the reduced-form equation and some alternative specifications intended as robustness checks. Column (1) presents the simplest specification with our main variable of interest ($CAT1$), the BLS responses and seasonal dummies, column (2) adds the macroeconomic controls (nominal investment growth by NFCs (*d_Investment*) and the *Eonia*) while column (3) incorporates time dummies.

The coefficient of the variable of interest $CAT1$ is always significant at the 5% level and varies only little from one specification to another. According to our baseline result, raising the ratio of Tier 1 own funds to the size of the balance sheet by 1 ppt leads, *ceteris paribus*, to a rise in credit growth by 1 ppt approximately. We here capture that banks with a higher capitalization will spur a more dynamic credit supply. This result is not unsettling in itself as a good chunk of our sample covers the upward part of the French credit cycle.

In practice, a positive shock to $CAT1$ could be implemented through 3 different ways:

- increasing the amount of Tier 1 capital (total assets being held constant),
- decreasing the amount of total assets (Tier 1 capital being held constant),
- Tier 1 capital increasing faster (or decreasing slower) than total assets.

Results presented in Table 5 point to a specific behavior of banks. In the first and third case, the bank has at disposal a greater share of capital (i.e. more unborrowed funds) which will allow it to supply more credit. Our regression reflects that feature. In the second case, the bank begins by shedding assets, leading to a higher share of capital compared to assets in the balance sheet, everything else held constant. Our results show that the bank re-accelerates its production of loans. In the light of table 5, the three cases indicate that French banks actively manage their balance sheets and their leverage. This feature echoes the work of Adrian and Shin (2010) on US

[14]In the end, the estimation finds 8 clusters in our sample.
[15]We are subject to the survivor bias to the extent that the selection process is not independent from the error term, given all regressors. See Baltagi and Song (2006).
[16]The surveyed bank switched to another branch of the consolidated group.

$QoQ\_NFCloans_t$	(1)	(2)	(3)
$CAT1_{t-1}$	0.912**	0.901**	1.116**
	(0.363)	(0.318)	(0.411)
$BLS\_S\_NoChge_{t-1}$	-0.044**	-0.049**	-0.045**
	(0.017)	(0.018)	(0.018)
$BLS\_S\_Tight_{t-1}$	-0.049**	-0.070***	-0.056**
	(0.017)	(0.019)	(0.019)
$BLS\_D\_NoChge_{t-2}$	0.021**	0.012*	0.005
	(0.006)	(0.006)	(0.005)
$BLS\_D\_Increa_{t-2}$	0.032***	0.023**	0.015
	(0.008)	(0.008)	(0.009)
NPL_{t-1}	-0.490	-0.301	0.294
	(0.322)	(0.328)	(0.450)
$d\_Investment_{t-2}$		0.413	
		(0.228)	
$Eonia_{t-2}$		0.009***	
		(0.002)	
Constant	0.016	-0.011	-0.007
	(0.026)	(0.024)	(0.034)
Fixed effects	YES	YES	YES
Crisis Dummy	YES	YES	NO
Data Quality Dummy	YES	YES	YES
Time Dummies	NO	NO	YES
Seasonal Dummies	YES	YES	NO
Observations	382	382	382
Adjusted R^2	0.066	0.094	0.115

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Reduced form credit equation - Baseline specifications. $\{BLS\_S_{i,t} = BLS\_S\_Eased_{i,t} = -1\}$, $\{BLS\_D_{i,t} = BLS\_D\_Decrea_{i,t} = -1\}$ are taken as the reference groups for the BLS variables.

commercial banks, which are found to have dynamically managed their assets and liabilities in order to maintain a constant leverage ratio.

Regarding control variables, columns (1) and (2) of table 5 show the relative relevance of the demand-related BLS variable which coefficients are positive. Aggregate loan demand by NFCs proxied here by the quarterly growth of NFCs nominal investment ($d\_Investment$)[17] turns out to be close to significativity and manages to capture some variability in our data as the coefficients of BLS_D become less significant. The time dummies in column (3) seem to wholly capture aggregate credit demand in the end. This probably reflects the lack of variance of loan demand at the individual level in our sample.

Turning to the supply side, the BLS responses related to credit standards are found to be significant at the 5% threshold with negative coefficients, i.e. tightened credit standards are associated with slower lending growth. Our results show again their high explanatory power and their relevance as in Del Giovane et al. (2011).[18] However, our proxy for the monetary stance in the Euro area (column (2)) turns out to have a significant positive effect on NFCs credit growth,[19] which seems at first sight surprising given that the higher financing cost for banks should translate into higher prices for NFCs and therefore a fall in demand. As in Francis and Osborne (2012) who found the same feature in the UK, our result can still be interpreted in two ways. First, policymakers may take into account bank credit when they are setting the monetary stance, and hence strong credit growth may trigger increases in the policy rate, which then take time to act on demand for credit. As a second explanation, we can envisage that, while increases in interest rates may reduce demand for credit, this change may actually result in firms becoming more dependent on banks, if an increase in the policy rate makes the access to disintermediated financing more difficult for firms (e.g. the reduction of informational asymmetries between borrowers and lenders by banks becomes more relevant during periods of tight monetary conditions, in contrast with market financing).

We fail to uncover any significant effects of the ratio of non-performing loans to total loans on credit growth with the basic specifications.

Table 6 allows the effect of the $CAT1$ ratio to vary with the bank group the observation belongs to. The interaction variables have been introduced with one lag in order to reflect the lagged effect of supervisory action on the bank's risk management. We find again the same significant positive effect of $CAT1$ on credit growth at the 5% level. But it is now higher, as it reflects the impact of $CAT1$ in our reference group, that is, group C (the third segment of $Buffer$). Results on the interactions of the $CAT1$ ratio with the group dummies show that the more stringent the supervisory constraint, the lower the effect of higher capital on credit growth. These results can be explained by the fact that the supervisory body limits the response of banks to an improvement of its capital ratio.

[17] Adding or replacing it by the change in inventories at NFCs do not change anything to our results.

[18] Costs of funds and the capital position are potential factors behind the answers given to the lending standards evolution by bankers to the BLS. They are indeed explanatory items suggested by the questionnaire itself. So entering both the capital ratio and the lending standards variable from the BLS could entail double counting of the information related to capital. To make sure our estimation does not suffer from this bias, we constructed a synthetic indicator of lending standards factors answers to the BLS, excluding costs of funds and balance-sheet constraints. It left the results unchanged for $CAT1$.

[19] Using another interest rate such as the Euribor 3M does not change our results.

$QoQ\_NFCloans_t$	(1)	(2)	(3)
$CAT1_{t-1}$	1.510***	1.293***	1.632**
	(0.357)	(0.350)	(0.496)
$Group\_A_{t-2}$	0.016	-0.015	-0.018
	(0.018)	(0.013)	(0.019)
$Group\_B_{t-2}$	0.029*	0.014	0.013
	(0.014)	(0.013)	(0.010)
$CAT1_{t-1} * Group\_A_{t-2}$	-0.459	-0.081	-0.103
	(0.303)	(0.214)	(0.278)
$CAT1_{t-1} * Group\_B_{t-2}$	-0.772***	-0.579***	-0.693***
	(0.169)	(0.116)	(0.175)
$BLS\_S\_NoChge_{t-1}$	-0.044**	-0.051**	-0.047**
	(0.017)	(0.017)	(0.017)
$BLS\_S\_Tight_{t-1}$	-0.049**	-0.071***	-0.056***
	(0.016)	(0.017)	(0.016)
$BLS\_D\_NoChge_{t-2}$	0.021**	0.013*	0.004
	(0.007)	(0.006)	(0.005)
$BLS\_D\_Increa_{t-2}$	0.033***	0.025**	0.017*
	(0.008)	(0.007)	(0.008)
NPL_{t-1}	-0.618	-0.461	0.192
	(0.337)	(0.344)	(0.451)
$d\_Investment_{t-2}$		0.405	
		(0.238)	
$Eonia_{t-2}$		0.010***	
		(0.003)	
Constant	-0.008	-0.020	-0.020
	(0.033)	(0.031)	(0.041)
Fixed effects	YES	YES	YES
Crisis Dummy	YES	YES	NO
Data Quality Dummy	YES	YES	YES
Time Dummies	NO	NO	YES
Seasonal Dummies	YES	YES	NO
Observations	382	382	382
Adjusted R^2	0.063	0.093	0.119

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Non-linearity induced by the supervisory constraint. $\{BLS\_S_{i,t} = BLS\_S\_Eased_{i,t} = -1\}$, $\{BLS\_D_{i,t} = BLS\_D\_Decrea_{i,t} = -1\}$ are taken as the reference groups for the BLS variables and group C for the dummy-based variables.

We fail to find any significantly different effect for group A from group C, i.e. banks being closest to their supervisory minimum and so supposedly under intense supervisory pressure does not have an influence on the association between the capital ratio and NFCs credit growth. Moreover, we can deduce from Table 6 that the coefficients of $CAT1 * Group\_A$ and $CAT1 * Group\_B$ are not significantly different. All in all, when looking at group C on the one hand and banks of group A and B combined on the other, our empirical results show that as a bank is more and more constrained by the supervisor, its response to an improvement in the capital ratio in terms of credit growth will be lower. We would like to stress that our present results reflect banks' behavior throughout the credit cycle. [20]

We refrain from commenting the results on the segment dummies themselves, since they only alter the coefficient of the constant. Results for the control variables are similar to those obtained in table 5.

Specifications that take into account the serial correlation of the dependent variable are presented in the appendix (table B.1) and confirms the previous qualitative results.

6.2 Capital Requirements and Non-Performing Loans

In this section, we test whether capital requirements induce non-linearity through another important risk-related variable than capital itself. We focus here on the ratio of non-performing loans to total loans granted, NPL as showed in table 7. Both the capital ratio $CAT1$ and NPL are standard riskmetrics and deeply linked together as rising non-performing loans may lead to the depletion of bank capital. Moreover, non-performing loans in the asset portfolio are automatically applied a 150% risk weight, which then calls for higher capital requirements. As the previous specifications did not reveal any significant linear impact of NPL despite its importance as a standard bank riskmetric, this section thus attempts to uncover any potential non-linear effects of NPL on credit growth.

In line with our baseline set-up in table 5, the ratio of non-performing loans is not significantly related to credit growth in the reference group (group C). In a similar way to the capital ratio, we show a higher significant negative effect as you move down across the groups of banks. This suggests that supervisory capital requirements induce the bank to be more cautious in their credit allocation, i.e. credit growth will be more responsive to non-performing loans if their share becomes too important. The estimated coefficient for group A is not always significant (see column (3) of table 7) and seems to point to the same phenomenon near the supervisory minimum requirement as for the capital ratio $CAT1$. Table B.2 in the appendix confirms this result in the case of autoregressive specifications.

7 Conclusion

This paper examines the different potential effects of bank capital ratio on credit growth using a bank-level analysis. It takes advantage of the bank-level answers to the Bank Lending Survey to be able to analyze the supply-side effects of capital on lending. It further makes use of the

[20] This can be put into perspective with Carlson et al. (2013) who focus on the crisis period (2008-2010). They find that in such extreme circumstances, the elasticity of bank lending with respect to capital ratios is actually higher when capital ratios are relatively low.

$QoQ\_NFCloans_t$	(1)	(2)	(3)
$CAT1_{t-1}$	0.881**	0.901**	1.173**
	(0.358)	(0.298)	(0.392)
NPL_{t-1}	0.040	0.052	0.718
	(0.311)	(0.370)	(0.482)
$Group\_A_{t-1}$	0.051**	0.028	0.019
	(0.018)	(0.018)	(0.017)
$Group\_B_{t-1}$	0.021	0.010	0.004
	(0.021)	(0.018)	(0.018)
$NPL_{t-1} * Group\_A_{t-1}$	-1.441***	-0.783**	-0.047
	(0.293)	(0.261)	(0.455)
$NPL_{t-1} * Group\_B_{t-1}$	-0.675**	-0.502*	-0.411*
	(0.228)	(0.214)	(0.194)
$BLS\_S\_NoChge_{t-1}$	-0.043*	-0.049**	-0.044*
	(0.019)	(0.019)	(0.021)
$BLS\_S\_Tight_{t-1}$	-0.054**	-0.072**	-0.057**
	(0.020)	(0.021)	(0.022)
$BLS\_D\_NoChge_{t-2}$	0.019**	0.012	0.006
	(0.007)	(0.007)	(0.006)
$BLS\_D\_Increa_{t-2}$	0.029***	0.023**	0.014
	(0.008)	(0.008)	(0.009)
$d\_Investment_{t-2}$		0.380	
		(0.242)	
$Eonia_{t-2}$		0.009**	
		(0.002)	
Constant	-0.004	-0.019	-0.023
	(0.035)	(0.032)	(0.044)
Fixed effects	YES	YES	YES
Crisis Dummy	YES	YES	NO
Data Quality Dummy	YES	YES	YES
Time Dummies	NO	NO	YES
Seasonal Dummies	YES	YES	NO
Observations	382	382	382
Adjusted R^2	0.070	0.091	0.115

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Non-performing loans and capital requirements. $\{BLS\_S_{i,t} = BLS\_S\_Eased_{i,t} = -1\}$, $\{BLS\_D_{i,t} = BLS\_D\_Decrea_{i,t} = -1\}$ are taken as the reference groups for the BLS variables and group C for the dummy-based variables.

confidential supervisory data on discretionary capital buffers required by the French supervisor to study the impact of capital requirements on credit growth, through both capital itself and the reaction to non-performing loans.

We show that supervisory capital requirements induce non-linearity in the reaction of credit growth to the share of capital with which a bank is funded. If on average, in our sample of French banks, we find that more capital means an acceleration of credit to non-financial corporations, this result must be viewed through the lenses of the intensity of supervisory requirements, measured as the difference between regulatory and economic capital. More supervisory capital-constrained banks' credit growth tend to be less responsive to a higher capital ratio than unconstrained banks. We thus show that supervisory capital is indeed a lever to curb lending.

Moreover, we show that this non-linearity is also present with the ratio of non-performing loans to total loans granted while no linear effect is detected. More supervisory capital constrained banks tend to be more reactive to this ratio than unconstrained banks. The former are more prone to reduce credit allocation after a rise in non-performing loans than the latter.

However, both aforementioned non-linear effects seem to weaken below or close to the supervisory minimum capital requirement.

This variation of the impact of both capital and non-performing loans with the intensity of supervisory capital constraints would have to be accounted for when designing the policy mix to fulfill macro-prudential objectives. Indeed, capital instruments are prominent in the macro-prudential policymaker toolkit. She can set countercyclical capital buffer, systemic risk buffer, G-SIFIs and D-SIFIs buffers. But she can also modify RWA weights on the housing sector or put limits on interbank exposures. Only the knowledge of the constraint being binding or not would allow her to anticipate the proper impact of the capital requirement on bank lending to the real economy. If the constraint is not binding for the most prominent players, other tools would have to be considered. If the constraint is not uniformly binding for all banks, secondary effects would probably arise, with credit supply distortions or substitutions.

References

Admati, A. and Hellwig, M. (2013), *The Bankers' New Clothes.* Princeton University Press.

Adrian, T. and Shin, H. S. (2010), Liquidity and leverage, *Journal of Financial Intermediation 19*(3), 418 – 437.

Aiyar, S., Calomiris, C. W., and Wiedladek, T. (2014), Does macro-prudential regulation leak? evidence from a uk policy experiment, *Journal of Money, Credit and Banking 46*(s1), 181–214.

Albertazzi, U. and Marchetti, D. J. (2010), *Credit supply, flight to quality and evergreening: an analysis of bank-firm relationships after Lehman.* Banca d'Italia.

Baltagi, B. and Song, S. (2006), Unbalanced panel data: A survey, *Statistical Papers 47*(4), 493–523.

Bassett, W. F., Chosak, M. B., Driscoll, J. C., and ZakrajÅ¡ek, E. (2014), Changes in bank lending standards and the macroeconomy, *Journal of Monetary Economics* (0), –.

Berg, J., Van Rixtel, A., Ferrando, A., De Bondt, G., and Scopel, S. (2005), The bank lending survey for the euro area, *ECB Occasional Paper No. 23*.

Bernanke, B. S., Lown, C. S., and Friedman, B. M. (1991), The credit crunch, *Brookings Papers on Economic Activity 1991*(2), pp. 205–247.

Berrospide, J. M. and Edge, R. M. (2010), The effects of bank capital on lending: What do we know, and what does it mean?, *International Journal of Central Banking*.

Blaes, B. (2011), *Bank-related loan supply factors during the crisis: an analysis based on the German bank lending survey*, Number 2011, 31. Discussion Paper Series 1: Economic Studies.

Brun, M., Fraisse, H., and Thesmar, D. (2013), The real effects of bank capital requirements, *Débats Economiques et Financiers, Autorité de Contrôle Prudentiel et de Résolution, Banque de France*.

Carlson, M., Shan, H., and Warusawitharana, M. (2013), Capital ratios and bank lending: A matched bank approach, *Journal of Financial Intermediation 22*(4), 663 – 687.

Ciccarelli, M., Maddaloni, A., and Peydró, J.-L. (2010), Trusting the bankers: A new look at the credit channel of monetary policy, Technical report, European Central Bank.

Del Giovane, P., Eramo, G., and Nobili, A. (2011), Disentangling demand and supply in credit developments: A survey-based analysis for italy, *Journal of Banking & Finance 35*(10), 2719–2732.

Dewatripont, M. and Tirole, J. (1994), A theory of debt and equity: Diversity of securities and manager-shareholder congruence, *The Quarterly Journal of Economics 109*(4), pp. 1027–1054.

di Patti, E. B., Sette, E., and d'Italia, B. (2012), *Bank balance sheets and the transmission of financial shocks to borrowers: evidence from the 2007-2008 crisis.* Banca d'Italia.

Francis, W. B. and Osborne, M. (2012), Capital requirements and bank behavior in the uk: Are there lessons for international capital standards?, *Journal of Banking & Finance 36*(3), 803–816.

Gambacorta, L. and Mistrulli, P. E. (2004), Does bank capital affect lending behavior?, *Journal of Financial Intermediation 13*(4), 436 – 457.

Gropp, R. and Heider, F. (2010), The determinants of bank capital structure, *Review of Finance 14*(4), 587–622.

Hempell, H. S. and Sørensen, C. K. (2010), The impact of supply constraints on bank lending in the euro area - crisis induced crunching?, Working Paper Series 1262, European Central Bank.

Jiménez, G., Ongena, S., Peydró, J.-L., and Saurina, J. (2012), Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications, *American Economic Review*.

Judson, R. A. and Owen, A. L. (1999), Estimating dynamic panel data models: a guide for macroeconomists, *Economics letters 65*(1), 9–15.

Lown, C., Morgan, D., and Rohatgi, S. (2000), Listening to loan officers: the impact of commercial credit standards on lending and output, *Economic Policy Review 6*(2), 1.

Lown, C. and Morgan, D. P. (2006), The credit cycle and the business cycle: new findings using the loan officer opinion survey, *Journal of Money, Credit and Banking*, 1575–1597.

Miller, M. H. (1995), Do the m & m propositions apply to banks?, *Journal of Banking & Finance 19*, 483 – 489.

Modigliani, F. and Miller, M. H. (1958), The cost of capital, corporation finance and the theory of investment, *The American Economic Review 48*(3), pp. 261–297.

Paris Europlace, F. (2013), Financement des entreprises et de l'economie francaise: pour un retour vers une croissance durable, Technical report, Paris Europlace.

Peek, J. and Rosengren, E. S. (2000), Collateral damage: Effects of the japanese bank crisis on real activity in the united states, *The American Economic Review 90*(1), pp. 30–45.

Repullo, R. and Suarez, J. (2013), The procyclical effects of bank capital regulation, *Review of Financial Studies 26*(2), 452–490.

Van der Veer, K. and Hoeberichts, M. (2013), The level effect of bank lending standards on business lending, *Working Paper, Netherlands Central Bank, Research Department*.

Wooldridge, J. M. (2003), Cluster-sample methods in applied econometrics, *American Economic Review 93*(2), 133–138.

A Sample's representativity

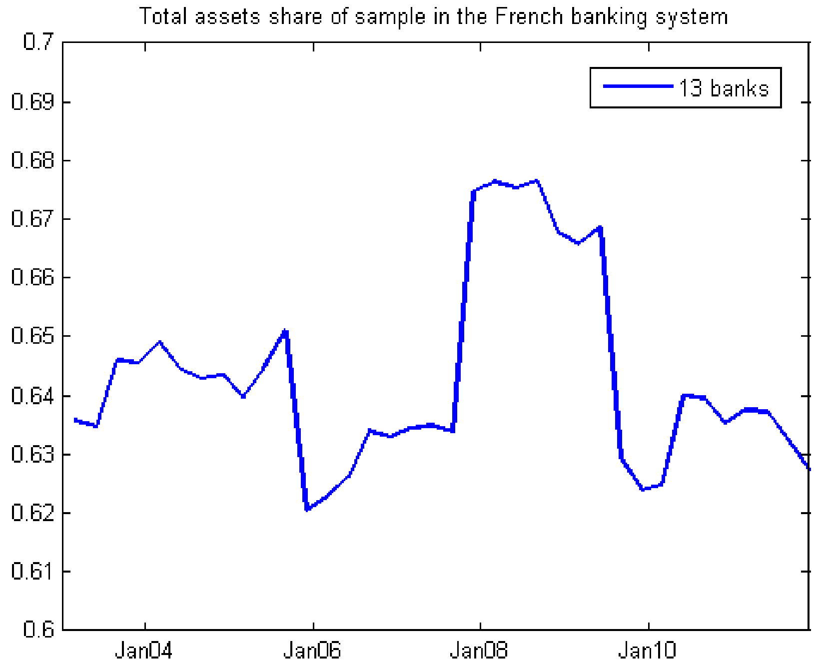

Figure A.1: Ratio of sample's assets on total aggregate banking assets.

B Reduced-form equation: robustness checks

B.1 With $CAT1$

Table B.1 takes into account the serial correlation of the dependent variable. These autoregressive models are also estimated with a standard fixed-effect routine following Judson and Owen (1999) results on panel with the time dimension larger than the cross-sectional one.

B.2 With NPL

Table B.2 takes into account the serial correlation of the dependent variable in the non-performing loans setting. Results are globally consistent with those underlined in the core of the paper.

$QoQ\_NFCloans_t$	(1)	(2)	(3)
$QoQ\_NFCloans_{t-1}$	-0.119**	-0.107**	-0.131**
	(0.049)	(0.045)	(0.047)
$CAT1_{t-1}$	1.177**	1.437***	1.772**
	(0.478)	(0.410)	(0.570)
NPL_{t-1}	0.193	-0.482	0.093
	(0.446)	(0.329)	(0.458)
$Group\_A_{t-2}$		-0.010	-0.014
		(0.013)	(0.021)
$Group\_B_{t-2}$		0.019	0.016
		(0.013)	(0.010)
$CAT1_{t-1} * Group\_A_{t-2}$		-0.147	-0.162
		(0.219)	(0.341)
$CAT1_{t-1} * Group\_B_{t-2}$		-0.684***	-0.777***
		(0.130)	(0.187)
$BLS\_S\_NoChge_{t-1}$	-0.048*	-0.053**	-0.049**
	(0.020)	(0.018)	(0.019)
$BLS\_S\_Tight_{t-1}$	-0.059**	-0.074***	-0.059**
	(0.022)	(0.018)	(0.018)
$BLS\_D\_NoChge_{t-2}$	0.007	0.015*	0.006
	(0.006)	(0.007)	(0.007)
$BLS\_D\_Increa_{t-2}$	0.019*	0.030**	0.022**
	(0.009)	(0.010)	(0.009)
$d\_Investment_{t-2}$		0.403	
		(0.245)	
$Eonia_{t-2}$		0.012***	
		(0.002)	
Constant	-0.013	-0.037	-0.030
	(0.038)	(0.037)	(0.045)
Fixed effects	YES	YES	YES
Crisis Dummy	YES	YES	NO
Data Quality Dummy	YES	YES	YES
Time Dummies	YES	NO	YES
Seasonal Dummies	YES	YES	NO
Observations	381	381	381
Adjusted R^2	0.123	0.106	0.130

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.1: Robustness checks : AR specifications. $\{BLS\_S_{i,t} = BLS\_S\_Eased_{i,t} = -1\}$, $\{BLS\_D_{i,t} = BLS\_D\_Decrea_{i,t} = -1\}$ are taken as the reference groups for the BLS variables and group C for the dummy-based variables.

$QoQ\_NFCloans_t$	(1)	(2)
$QoQ\_NFCloans\_t-1$	-0.110**	-0.130**
	(0.042)	(0.045)
$CAT1\_t-1$	0.966**	1.241**
	(0.356)	(0.464)
NPL_{t-1}	0.066	0.637
	(0.379)	(0.498)
$Group\_A_{t-1}$	0.033	0.023
	(0.020)	(0.020)
$Group\_B_{t-1}$	0.012	0.004
	(0.020)	(0.021)
$NPL_{t-1} * Group\_A_{t-1}$	-0.883**	-0.154
	(0.286)	(0.468)
$NPL_{t-1} * Group\_B_{t-1}$	-0.533*	-0.434*
	(0.255)	(0.217)
$BLS\_S\_NoChge_{t-1}$	-0.051**	-0.046*
	(0.021)	(0.023)
$BLS\_S\_Tight_{t-1}$	-0.076**	-0.060**
	(0.023)	(0.025)
$BLS\_D\_NoChge_{t-2}$	0.014	0.007
	(0.008)	(0.007)
$BLS\_D\_Increa_{t-2}$	0.027**	0.019*
	(0.010)	(0.010)
$d\_Investment_{t-2}$	0.374	
	(0.248)	
$Eonia_{t-2}$	0.010***	
	(0.002)	
Constant	-0.034	-0.031
	(0.038)	(0.048)
Fixed effects	YES	YES
Crisis Dummy	YES	NO
Data Quality Dummy	YES	YES
Time Dummies	NO	YES
Seasonal Dummies	YES	NO
Observations	381	381
Adjusted R^2	0.104	0.125

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.2: Non-performing loans and serial correlation for credit growth. $\{BLS\_S_{i,t} = BLS\_S\_Eased_{i,t} = -1\}$, $\{BLS\_D_{i,t} = BLS\_D\_Decrea_{i,t} = -1\}$ are taken as the reference groups for the BLS variables and group C for the dummy-based variables.