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Assessing the Impact of Basel III on European Bank Lending*

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Abstract

The failures of the banking sector to promote sustainable lending and build substantial capital and liquidity buffers prior to the 2008 Financial Crisis addressed the rationale for implementing Basel III. In this paper, we question the fundamental role of this new regulatory regime in promoting bank lending specifically for European systemic banks. Our empirical findings suggest that Basel III had no detrimental effects on bank lending. Instead, the capital and liquidity standards appear to strengthen the credit structure for this type of bank. Our results also suggest that a credit crunch scenario in Europe is likely due to the deterioration of the quality of the loan portfolio rather than the application of stricter regulatory requirements.

Keywords: Basel III, Credit Crunch, Capital, Funding, Bank Lending

JEL classification: G18, G21, G28

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"Banking operations may be varied and complex, but a simple operational definition of a bank is available: *a bank is an institution whose current operations consist in granting loans and receiving deposits from the public.*" (Freixas and Rochet, 2008)

1 Introduction

The 2008 Financial Crisis and its aftermath had shed some light on the need to reconsider the design of banking regulation in order to promote the resilience of the international banking system. In recognition of the need to strengthen the capital base and support sustainable liquidity management practices, the Basel Committee designed a new set of financial reforms known as Basel III. One of the novel aspect of this regulation lies at the heart of the structure of the prudential regime. In addition to more stringent rules on capital, Basel III introduces two liquidity standards, namely the LCR (Liquidity Coverage Ratio) and the NSFR (Net Stable Funding Ratio).[1] The novel aspect of this structure questions its impact on bank behavior, specifically on bank lending. One important question, which remains a debate of intensive research, is to determine whether the implementation of this new regulatory regime had positive effects on lending and thus contributed to economic growth.[2]

This question also calls for a deeper understanding of the impact of the newly introduced Basel standards on bank behavior. Examining such an impact is, however, not new. A large stream of literature supporting the effectiveness of the 1988 Basel Capital Accord shows that banks adopted different strategies to comply with the first international standard on capital. Among these strategies, banks were able to adjust their balance-sheets, including restructuring their lending activity.[3] The implementation of tighter capital standards under Basel III has revived the interest in this topic and questioned the possibility of such an impact at the macroeconomic level illustrated under the *credit crunch* hypothesis during the implementation of Basel I.

[1] An important body of literature has urged for the design of a counter-cyclical prudential regulation since the implementation of the first Basel Capital Accords. Analyzing such aspect of banking regulation is however beyond the scope of this paper.

[2] For a discussion on this topic, see, for example, Alan Beattie, "Fears on fresh bank rules overblown" Financial Times, September 12, 2012.

[3] The literature shows that other balance-sheet adjustments were possible. Banks were able to reduce the size of their balance-sheet "downsizing" or modify the composition of their assets illustrated under the "portfolio-shift". For a complete review of these studies, see Jackson et al. (1999) and BCBS (2016).

Based on a sample of 148 UK banks for the period 1996-2007, Francis et al. (2009) analyze the impact of capital requirements on bank behavior. Their methodology has the main advantage to provide an analytical framework by which they assess this impact on the choice of capital dotation and lending. They find that the implementation of capital standards is positively associated with the banks' targeted capital ratios and lending. Cosimano & Hakura (2011) examine the impact of the Basel III capital standards on lending rates and growth. They find that a tightening of capital requirements gives incentives to banks to increase lending rates, causing a slowdown in credit supply. Cohen & Scatigna (2016) show that banks from advanced economies comply with the Basel III capital requirements through the accumulation of retained earnings and, to a lesser extent, shifting to assets with lower risk weights without detrimental effects on lending. Gropp et al. (2019) question the impact of higher capital requirements on bank lending and, to a large extent, on the real economy. Using a quasi-natural experiment, the authors find that banks reduced their level of risk-weighted-assets when subject to the Basel III standards. In addition, banks facing higher capital requirements tend to lend less questioning thus the strategy to adopt for clearing the ratio.

This stream of literature remains focused on the effects of capital requirements on bank lending. However, an emerging body highlights the role of liquidity on lending and its consequences for the real economy.[4] King (2013) disentangles the different banks' strategies to meet the NSFR. Among these strategies, the bank can shrink the size of the portfolio of loans (downsizing) or substitute them for more liquid assets (portfolio-shift), thus modifying the composition of their assets and bank lending. Gobat et al. (2014) examine the impact and issues raised by the implementation of such a ratio for a large panel of banking systems. They also highlight the potential adverse effect of the NSFR on bank lending, especially for large Domestic Systemically Important Banks (D-SIBS). Kapan & Minoiu (2018) show that the funding structure may impact the lending activity of banks and the real activity as a whole. Using banks' balance-sheet data, Banerjee & Mio (2018) study the impact of the Individual Liquidity Guidance (ILG), a liquidity ratio close to the LCR,[5] on the UK banking sector. They find that banks did not shrink the size of their balance-sheet but rather modify its composition without

[4] As argued in Tirole (2011), liquidity covers different aspects. In this paper, we define the concept of liquidity as the funding structure of the bank. A concept close to the NSFR.

[5] The LCR corresponds to the liquidity standard requiring from banks to hold highly liquid assets to cover short-term liquidity needs. For more details, see BCBS (2011).

causing deleterious effects on bank lending. The implementation of liquidity standards suggests similar balance-sheet adjustments than those observed under Basel I and Basel II.

The adjustments induced by the capital and liquidity ratios suggest that the two ratios might have common implications for bank behavior and, therefore, financial stability. For example, Tirole (2011) shows that the definition of capital requirements under Basel I lend considerations for liquidity through the emission of capital.

Using a sample of 11,000 banks across the US and Europe, Dietrich et al. (2014) analyze the relationship between bank funding structures, capital leverage, and failures with a particular focus on Global Systemically Important Banks (G-SIBS) and D-SIBS. Overall, the authors find that banks with weak liquidity structures and leverage tend to be more subject to failures. In addition, they show that the nature of bank failures is different across bank types. Small banks are more sensitive to failures when subject to liquidity issues, while the failure of large banks occurs on the holding of an insufficient capital base. Ben Naceur et al. (2017) study the impact of capital and liquidity indicators on bank lending to draw the main implications of a regime *à la* Basel III for US and European commercial banks. They find that the impact of the capital and liquidity structures of the bank may differ depending on heterogeneous bank specific characteristics.

Kim & Sohn (2017) underline the role of liquidity in the standard relationship between bank capital and lending. Overall, they find a significant impact of liquidity on the bank capital-lending relationship. They show that the relationship differs depending on the size of the bank. The effect of an increase in bank capital on credit growth is positively associated with the liquidity level for large banks, while this relationship is non existent for medium and small banks. Kapan & Minoiu (2018) outline the importance of bank capital in the relationship between the bank funding structure and lending. The authors find that weak balance-sheet structures, i.e., banks relying heavily on market funding, were less able to provide credits to the economy. However, better-capitalized banks tend to slow down the volume of credits less than other banks.

De Young et al. (2018), using a sample of US banks, investigate the liquidity behavior of banks under negative capital shocks. The authors emphasize the need to consider the size of banks for the design of banking regulation. They show that small U.S. bank holding companies adopt sufficiently sound liquidity management practices before and after the crisis and presents no financial stability risk. On the other hand, they find no similar behavior for large commercial banks.

As underlined above, the macroeconomic implications of banking regulation have been revived, particularly in the light of the monetary policy conduct. Financial intermediaries are at the core of monetary policy transmission through bank loan supply. Based on a dynamic model of Asset and Liability Management (ALM), Van den Heuvel et al. (2002) provide the premise of the role of bank capital in the transmission of the monetary policy. They show that monetary policy might be non-neutral on bank lending, especially through the emission of bank capital. This mechanism, illustrated under the bank capital channel, shows that bank capital is an important monetary policy transmission mechanism. Gambacorta & Marques-Ibanez (2011) show that bank-specific characteristics such as capitalization and funding are important determinants of monetary transmission mechanisms in Europe and the US. Gambacorta & Shin (2018) evidence the role of bank capitalization on the conduct of monetary policy. They find that weakly capitalized banking systems are associated with high bank funding costs, thus reducing the lending capacity of the banking system. This mechanism has detrimental effects on the objective of monetary policy, which is boosting sustainable lending following a negative shock.

To our knowledge, the literature examining the effects of capital and liquidity standards on bank behavior is still developing, likely because liquidity standards set at the international level has been mainly motivated since the implementation of Basel III.[6] Based on a novel metric of the bank funding structure, we contribute to the debate by examining whether systemic banks in Europe were subject to a credit crunch scenario following the implementation of Basel III.

The remainder of the paper is organized as follows: In section 2, we draw a theoretical model of bank behavior under Basel III. Section 3 presents the data and the econometric methodology. Section 4 discusses the results. Finally, section 5 concludes.

[6] Note that the Basel Committee published "Sound Practices for Managing Liquidity in Banking Organisations" in 2000. However the unprecedented liquidity crisis experienced by the banking sector in 2008 urged for an effective liquidity regulatory framework.

2 Theoretical Framework

In this section, we develop a model of bank balance-sheet adjustments drawn upon Ito & Sasaki (1998). Their model is suitable for depicting and understanding banks' behavior under Basel I and Basel II as the prudential structure of these two regulatory regimes are capital-driven. However, the introduction of liquidity requirements under Basel III questions the implications of a prudential structure, both capital, and liquidity-driven, on bank behavior. Our contribution is adding liquidity requirements to the model introduced in Ito & Sasaki (1998) to assess the effects of such a new regulatory structure on bank behavior. In addition, we model the Risk-Weighted-Asset (RWA) metric designed under Basel II and Basel III.

2.1 The Bank Business Model

We assume that banks buy credits to households and firms, whether retail, commercial, wholesale or universal banks.[7] Investment banks are not considered to distribute credits and are involved in financial activities such as trading and mergers and acquisitions (M&As). We depict these credits as mortgage, credit cards, or commercial loans, defined through a unique loan portfolio held by the bank.

The credit risk related to these loans plays a central role in the model as we focus on the credit activity of the bank. For the sake of simplicity, we consider the bank is government-bond buyer on the market. Thus, the market risk is nil because government bonds are risk-free assets in the model.

We propose this simple bank investment decision problem for two reasons. First, our objective is to study the impact of capital and liquidity rules on lending. We reduce the bank investment decision problem to two dual assets, one risky asset (loans) for which the bank has to provide sufficient capital and liquidity coverages and one risk-free asset (government bonds) requiring neither capital nor liquidity coverage.

Second, defining a risky market portfolio induces introducing additional hypotheses in the

[7] Following Freixas & Rochet (2008), we define the bank as a financial intermediary buying and selling financial claims. In particular, we consider the bank funds its lending and market activities through the selling of financial liabilities.

model while our research question remains the same. We choose to keep the simplified version following Ockham's razor principle even if a more general specification including market risky securities could be developed.

We assume capital K and customer deposits D fund loans L and government bonds B, where K represents the capital issued by the bank. The maturity of capital is infinite. D is a resource comprising both *non-maturity deposit and term deposit.* In sum, the bank's activity consists of buying a portfolio of loans L and government bonds B, selling capital K, and customer deposits D.

We depict the balance sheet of the bank as follows:

Assets			Liabilities
L	Loans	Capital	K
B	Government Bonds	Customer Deposits	D

We consider the loan activity of the bank as the primary source of illiquidity. The portfolio of government bonds defines the total amount of liquid assets the bank can buy. Finally, capital and customer deposits define the sources of available funding the bank disposes of for covering the funding risk induced by the credit activity. The loan decision process of the bank is characterized by the parameter $0 < \theta \leq 1$, which is the risk default on loan and the return r_L at which the bank charges the loan. Therefore, the product θL defines the credit risk the bank is willing to bear on the loan activity. Assuming a competitive loan market environment, the bank is willing to decrease the loan interest rate to raise the volume of loans bought by one unit, setting $r'_L(L) < 0$.[8]

The introduction of the parameter θ allows us to better account for the aggregate risk related to the bank lending activity. An exogenous shock may increase the overall credit risk, as was the case in 2008. This risk parameter is necessary to measure the credit risk assessed in the required ratios. The market activity of the bank consists of buying a risk-free portfolio of bonds, typically high-graded government bonds excluded from the regulatory risk-asset base given a risk-free rate r_B. Thus, the portfolio of loans defines the total asset risk-exposure of the bank

[8] Assumptions on the second derivative of the interest rates will be discussed later on.

since the market-risk is nil in the model. We suppose that issuing capital and deposits is costly for the bank. Thus, we set $r'_K > 0$ and $r'_D > 0$ as the bank has to offer attractive capital and deposits to obtain one more unit from investors and depositors.

2.2 Regulatory Requirements

The Basel III measures aim at providing a "global regulatory framework for more resilient banks and banking systems" BCBS (2011). Reforming the Basel II Accords was about "strengthening the global capital framework" and "introducing a global liquidity standard" (*ibid.*). The introduction of liquidity requirements is the most significant change in the regulatory framework and is a direct consequence of the liquidity crisis faced by the banking industry in 2008 when the subprime mortgage crisis has triggered. Our theoretical approach underlines the impact of these new liquidity requirements on bank lending. In view of this, we propose transposing the Basel III regulatory ratios.

2.3 The Capital Requirement Ratio (CRR)

Due to the insufficient build-up of capital coverage during the financial crisis, the Basel Committee proposed to tighten the definition of capital under Basel III. The bank regulatory capital base has been classified into two categories denominated "Tier". We define K as Tier 1, the best-quality capital, including the Common Equity Tier 1 Capital (CET1) and the Additional Tier 1 Capital (AT1) plus Tier 2.[9] The regulatory capital of the bank is thus equal to K. The Basel III Total Capital Ratio (TCR) is the sum of Tier 1 and Tier 2 and complemented regarding the bank asset risk-exposure:

$$\text{TCR} = \frac{\text{Regutatory capital}}{\text{Risk-weighted assets}}$$

RWAs are the sum of the risks incurred by the bank. They consist of credit risk, market risk, and operational risk. Since both market and operational risk are nil in the model, the TCR can be rewritten as follows:

$$CRR = \frac{K}{\theta L} \tag{1}$$

CRR defines the total amount of capital available to the bank to cover the credit risk and

[9]Note that Tier 3 aiming at covering the market risk under Basel II has been removed in Basel III.

corresponds to the TCR. The CRR we propose differs from the capital ratio standard developed by Ito & Sasaki (1998) to the extent that we introduce the parameter θ. However, the two regulatory ratios are similar for $\theta = 1$.[10] The credit risk θL is a positive linear function of L and is measured in currency units, as it is the case for the Value-at-Risk (VaR), which is used to assess the RWAs under Basel II and Basel III. This metric is consistent with the underlying logic of VaR, "which is a lower tail percentile for the distribution of profit and loss (P&L)" Berkowitz & O'Brien (2002). All things being equal, the higher the aggregate risk related to banks' lending activity, the higher the credit risk. Similarly, the higher the volume of loans bought by the bank, the higher the credit risk.[11] This phenomenon complies with the "fallacy of large numbers" in Samuelson (1963) since the "maximum loss" increases with the size of the portfolio of loans.

2.4 The Liquidity Requirement Ratio (LRR)

In addition to strengthening the global capital framework, the Basel Committee designed a new liquidity framework as the banking sector failed to enter the financial crisis with adequate liquidity buffers. More specifically, the Basel Committee emphasized the need for better liquidity risk management and published in 2008 "Principles for Sound Liquidity Risk Management and Supervision", which has been complemented by the introduction of two minimum liquidity regulatory standards under "Basel III: International framework for liquidity risk measurement, standards and monitoring" in 2010.

While the LCR is designed to improve the short-term resilience of the banking sector to meeting liquidity obligations for 30 days, the NSFR requires to meet funding obligations under a time horizon of one year. This last ratio is designed to promote sustainable sources of funding when banks perform maturity transformation activities such as credit origination.

We choose to model a liquidity ratio close to the NSFR because "Maturity transformation performed by banks is a crucial part of financial intermediation that contributes to efficient resource allocation and credit creation." BCBS (2014). In addition, as underlined in EBA (2015), the NSFR "is needed in addition to the solvency requirements (capital and leverage ratio) and

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[10] Ito & Sasaki (1998) add the term *fukumi* to the book value of shareholders' equity which is equivalent to mark-to-market valuation.

[11] If the aggregate risk for loans was nil, the VaR would equal zero and thus $\theta = 0$. The market risk is nil in the model as the bank buys risk-free bonds which is equivalent to a zero VaR within the Basel framework.

the LCR, because these existing requirements miss important aspects of structural funding stability."

We contribute to the emerging literature by modeling a funding requirement ratio close to the NSFR to assess to what extent the adoption of this ratio modifies the bank lending behavior. As defined in BCBS (2014): "The NSFR is defined as the amount of available stable funding relative [AASF] to the amount of required stable funding [RASF]. This ratio should be equal to at least 100 % on an on-going basis. "Available stable funding" is defined as the portion of capital and liabilities expected to be reliable over the time horizon considered by the NSFR, which extends to one year. The amount of stable funding required "is a function of the liquidity characteristics and residual maturities of the various assets held by the bank as well as those of its off-balance sheet (OBS) exposures." (BCBS, 2014).

The liabilities taken into account to assess the available stable funding (ASF) are weighted using an ASF factor between 0 % and 100 % (e.g., for Tier 1 liabilities and Tier 2 liabilities with a maturity above one year). Symmetrically, the assets taken into account to assess the required stable funding (RSF) are weighted using an RSF factor which is between 0 % (e.g., for central bank reserves and risk-free securities) and 100 %, e.g., for "all assets that are encumbered for a period of one year or more" (BCBS (2014), p.11). The NSFR can thus be defined as follows:

$$NSFR = \sum_i \frac{L_i \times ASF_i}{A_i \times RSF_i}$$

where: L_i is the total amount of liabilities which belongs to the category i defining an ASF factor of ASF_i, and A_i is the total amount of assets belonging to the category i defining an ASF factor of RSF_i.

Based on this definition, we transpose the equivalent of the NSFR in the model. Capital K (Tier 1 + Tier 2) receives an ASF factor of 100 %. Deposits composed of term and non-maturity customer deposits define an ASF factor of 95 % or 90 % under the Basel III framework. For the sake of simplicity, we also consider an ASF factor of 100 % for D. As a consequence; the $AASF$ equals $(K + D)$ in the model.

The $RASF$ induced by the banking activity is related to each asset held by the bank. Since the market risk is nil for government bonds B, they define a 0% RSF factor. Loans have a credit risk parameter equals to θ. Following the Basel III principle that the higher the risk, the higher the RSF factor, we assume that loans L receive an RSF factor of θ. The assets with the highest VAR also have a high level of required stable funding: such as the unencumbered residential mortgages (65 % RSF factor) and the other unencumbered performing loans (85 % RSF factor).[12] This symmetry is respected in the model where the credit risk is set equal to the requirement amount of stable funding for loans.

Applying the former NSFR formula to the model, we obtain the following liquidity requirement ratio:

$$LRR = \frac{(K \times 1) + (D \times 1)}{(L \times \theta) + (B \times 0)}$$

LRR measures the total amount of available funding (capital plus deposits) the bank disposes of to cover the funding risk induced by the credit activity and can be rewritten as follows:

$$LRR = \frac{(K + D)}{\theta L} = CRR + \frac{D}{\theta L} \tag{2}$$

This result shows that CRR and LRR are not orthogonal by construction and modifies the funding choice structure of the bank: a rise in CRR implies a rise in LRR while a rise in LRR does not necessarily entail a rise in CRR.

More specifically, raising K increases both CRR and LRR while increasing D only improves LRR. This suggests that implementing a capital ratio as in Basel I and Basel II might imply satisfying a specific funding profile. This result is consistent with Tirole (2011). Collecting long-term debt through capital emission obliges the bank to satisfy a specific funding profile.

The metric LRR is central to understanding the functioning of banking institutions. As

[12] See BCBS (2014), p.11.

underlined in Berger & Bouwman (2009), banks are essential in the modern theory of financial intermediation as they perform liquidity creation and risk transformation. Banks create liquidity by funding illiquid assets with liquid liabilities, which corresponds to the deposit-to-loan ratio $\frac{D}{L}$ in the model. Second, banks act as risk transformers. As stated in (Berger & Bouwman (2009), p.3780), "banks transform risk by issuing riskless deposits to finance risky loans". We take into account such an aspect regarding the introduction of the parameter θ notably. We measure the banking risk transformation via the ratio $\frac{D}{\theta L}$.

2.5 Properties of the Cost Function

We define the implementation of the capital and liquidity ratios as incentives given to the bank.

These incentives are reflected through the cost function $C(L, K, D)$ which measures the opportunity costs the bank may incur not expanding its business activities. Implementing capital and liquidity requirements also entails regulatory costs, which take the form of compliance costs for the bank. In addition, restriction costs appear when the bank satisfies no standards.[13]

We consider that a bank with low capital and liquidity ratios incurs an important opportunity cost not expanding its business activities as a strong capital base is necessary to support lending[14], and "Deposits are used to fund loans and other earning assets" (Spierdijk et al. (2017), p.2). High ratios are a signal for good bank business opportunities and conduct.

The cost function $C(L, K, D)$ also measures the management costs related to the capital and liquidity positions of the bank. The NSFR emphasizes the funding risk of intermediation, i.e., funding illiquid assets with liquid liabilities. The bank manages such a risk through its Asset and Liability Management (ALM) activity. In addition to measuring the quality of the management of the capital position, the cost function $C(L, K, D)$ measures the quality of the ALM activity.

[13] A bank satisfying no regulatory standard incurs restriction costs as regulatory authorities monitor the credit activities of the bank. If there is no regulation, $C(L, K, D) = 0$ by definition.

[14] For example, see BCBS (2011).

2.6 Bank Behavior under Basel III

To analyze the behavior of the banking firm under Basel III, we consider a representative bank seeking to maximize its profits under a capital and liquidity constrained environment.

The constraints the regulatory authorities implement take the form of incentives and, specifically, ratios the bank is expected to comply with. These ratios are central to the bank decision process since the bank uses them as profitability indicators. Ito & Sasaki (1998) assume that "the cost of the [regulatory capital] ratio is reduced as the ratio increases while its rate of change is diminished or constant; ($C' < 0$, $C'' \geq 0$). It means that banks with a low [regulatory capital] ratio can improve profit more by raising the ratio than banks with a high [regulatory capital] ratio" (Ito & Sasaki (1998), p.15).

We define L and K among the bank decision variables of the profit maximization problem as in Ito & Sasaki (1998). However, deposits D become central within the bank decision problem because the NSFR is designed to give incentives to the bank to fund its business activities with stable sources of funding such as customer deposits: "The second objective is to promote resilience over a longer time horizon by creating additional incentives for a bank to fund its activities with more stable sources of funding on an ongoing structural basis. The NSFR has a time horizon of one year and has been developed to provide a sustainable maturity structure of assets and liabilities " (BCBS (2011), p.9).

To picture the importance of collecting deposits, we set the following assumption on customer deposits: $r'_D(D) > 0$, meaning the bank raises more customer deposits when increasing its return.

We define the bank's profits, denoted Π as the sum of its revenues on the credit and market activities net of the costs on capital, deposits, and the costs induced by the regulation. Increasing the volume of loans bought is costly $C'_L > 0$ as the regulatory ratios of the bank are lower, thus reducing its ability to cover capital and liquidity losses ceteris paribus. Cohen & Scatigna (2016) find that the lending activity of European banks was not altered by the cleaning of the capital ratio, which does not lend support for a credit crunch hypothesis. In line with this result, we believe that a rise in capital or deposits decreases the cost to expand the business opportunity of the bank. Thus, we set $C'_K < 0$ and $C'_D < 0$.[15]

The profit equation of the bank can be thus written as follows:

$$\Pi = r_L(L).L + r_B.B - r_K(K).K - r_D(D).D - C(L, K, D)$$

We reduce the optimization problem of the bank as an ALM problem in order to assess the impact of banking regulation on bank lending:

$$\max_{L,K,D} \Pi = r_L(L).L + r_B.B - r_K(K).K - r_D(D).D - C(L, K, D)$$
$$\text{s.t. } L + B = K + D$$

Solving this profit-maximization problem with the Lagrangian method gives the following first-order economic conditions:

$$r_L(L) - r_K(K) = C'_L + C'_K - (r'_L(L) \cdot L - r'_K(K) \cdot K), \tag{3}$$

$$r_K(K) - r_D(D) = C'_D - C'_K + r'_D(D) \cdot D - r'_K(K) \cdot K, \tag{4}$$

$$K + D - (L + B) = 0. \tag{5}$$

Eq.3 means that the difference between the loan and capital rate - the Net Interest Margin (NIM) - equals the sum of the marginal regulatory costs on loans and capital $(C'_L + C'_K)$ net of the marginal profit derived from the intermediation activity $(r'_L(L) \cdot L - r'_K(K) \cdot K)$.

Rising the portfolio of loans bought L entails an increase in the NIM $(r_L(L) - r_K(K))$ as managing a higher illiquid portfolio of loans is costly. Other things being equal, the bank has to pay a higher price $(C'_L - r'_L)$ for its ALM.

Eq.4 states that the funding arbitrage of the bank – the difference between the capital and deposit rate – equals the marginal regulatory cost difference between deposits and capital plus

[15]Note that as in Ito & Sasaki (1998), we can set the cost function depending on the ratios, e.g., $C'_{CRR} < 0$ and $C'_{LRR} < 0$. However, we want to understand the impact of the regime on the balance-sheet components.

the marginal market funding cost on these same liability components.

Assuming the funding arbitrage is positive, the bank has an incentive to raise deposits D at the expense of capital K. However, selling more deposits is costly at the margin. Thus, the bank issues deposits to the extent that the marginal cost of issuing them equals the marginal cost of issuing capital.

The implementation of the additional liquidity ratio LRR shows that the bank funding arbitrage is both capital and deposit-driven while it is only capital-driven under a regulatory environment such as Basel I and Basel II.

Eq.5 simply refers to the balance-sheet equilibrium constraint.

We assume $d\theta = 0$, which means that the bank implements the right screening mechanism and is, therefore, able to perfectly assess the credit risk of the borrower in the short-run. We obtain the following elasticities by totally differentiating eq.3 and eq.4 at the third order:[16]

$$dK = \frac{\delta_3 \cdot dD - \delta_1 \cdot dL}{\delta_2}; \tag{6}$$

$$dD = \frac{\delta_4 \cdot dK + \delta_6 \cdot dL}{\delta_5}; \tag{7}$$

where the coefficients are given by:

$\delta_1 = r''_L(L) \cdot L + 2 \cdot r'_L(L) - \left(\frac{\partial^2 C}{\partial L^2} + \frac{\partial^2 C}{\partial L \, \partial K} \right);$

$\delta_2 = r''_K(K) \cdot K + 2 \cdot r'_K(K) + \frac{\partial^2 C}{\partial K^2} + \frac{\partial^2 C}{\partial K \, \partial L};$

$\delta_3 = \frac{\partial^2 C}{\partial D \, \partial L} + \frac{\partial^2 C}{\partial D \, \partial K};$

$\delta_4 = r''_K(K) \cdot K + 2 \cdot r'_K(K) + \frac{\partial^2 C}{\partial K^2} - \frac{\partial^2 C}{\partial K \, \partial D};$

$\delta_5 = r''_D(D) \cdot D + 2 \cdot r'_D(D) + \frac{\partial^2 C}{\partial D^2} - \frac{\partial^2 C}{\partial D \, \partial K};$

[16] Note that developing the model at further order is possible. However, we do not do so because the economic interpretation would not be straightforward.

$$\delta_6 = \frac{\partial^2 C}{\partial L\, \partial K} - \frac{\partial^2 C}{\partial L\, \partial D};$$

$$\frac{dL}{dK} = \frac{\left(\delta_2 + \dfrac{\delta_3 \cdot \delta_4}{\delta_5}\right)}{\left(\delta_1 - \dfrac{\delta_3 \cdot \delta_6}{\delta_5}\right)}; \tag{8}$$

$$\frac{dL}{dD} = \frac{\left(\delta_5 + \dfrac{\delta_4 \cdot \delta_3}{\delta_2}\right)}{\left(\delta_6 + \dfrac{\delta_4 \cdot \delta_1}{\delta_2}\right)}. \tag{9}$$

Totally differentiating eq.3 and eq.4 stresses three important results.

First, we see that the elasticities are market-driven via the conduct of the first and second derivatives of the interest rates $r'(.)$ and $r''(.)$ obtained in δ_1, δ_2, δ_4 and δ_5.

Second, we note that these elasticities are also regulatory-driven. In addition to introducing banking adjustment and marginal regulatory costs as we have seen so far, the capital and liquidity requirements potentially add secondary costs $\left(\dfrac{\partial^2 C}{\partial (.)^2}\right)$ and cross-effects $\left(\dfrac{\partial^2 C}{\partial (.)\, \partial (.)}\right)$.

The nature of these secondary costs and cross-effects may modify the structure of the elasticities of the bank and thus its behavior. As stated in Freixas & Rochet (2008), if costs are separable, then cross-effects are nil. If cross-effects are not nil, then the elasticities are modified and determined depending on the functional form of the cost function. It is crucial to determine the nature of these costs because they may affect the profitability, the NIM, the funding arbitrage, and the elasticities of the bank as a whole. Therefore, the regulation may not be neutral.

Third, as in Ito & Sasaki (1998), the signs of these elasticities "may not be uniquely determined." We find that they depend on the costs that the regulation entails and, second, the structure of the competition the bank faces on the market. For small enough C'', the signs of the elasticities depend on the structure of this competition, and the regulation has only effects on the profitability, the NIM, and the funding arbitrage of the bank:

$$\frac{dL}{dK} \simeq \frac{r''_K(K) \cdot K + 2 \cdot r'_K(K)}{r''_L(L) \cdot L + 2 \cdot r'_L(L)}; \tag{10}$$

$$\frac{dL}{dD} \simeq \frac{r''_D(D) \cdot D + 2 \cdot r'_D(D)}{r''_L(L) \cdot L + 2 \cdot r'_L(L)} \cdot \tag{11}$$

The sign of the loan-to-capital elasticity depends on the condition set on δ_1 and δ_2. Assuming the competitive pressure on the loan market increases as the bank buys a greater portion of loans ($r''_L > 0$), "the rate of increase accelerates as more subordinated debts being issued" Ito & Sasaki (1998)[17] and the deposit interest rate follows the same pattern than capital ($r''_D > 0$), it follows:[18]

$$\frac{dL}{dK} > 0\,; \tag{12}$$

$$\frac{dL}{dD} > 0 \cdot \tag{13}$$

This result is consistent with the set of hypotheses related to the risk absorption capacity of the bank. On the other hand, for small values of L, the sign of the elasticity of capital to lending is negative, suggesting that the financial fragility crowding-out hypothesis prevails.[19] In this paper, we set that a bank increasing its capital ratio decreases the cost of opportunity to extend its business as in Ito & Sasaki (1998). Ceteris paribus, a rise in capital, would favor bank lending.

3 Data and Econometric Methodology

3.1 Data treatment

We obtain the data based on the availability of bank balance-sheets and income statements in Moodys' Bank Focus, a commercial database maintained by Moody's. This database has the main advantage to benefit from a large coverage of European banks. We present financial statements under a standardized and consolidated format. We cover the period 2011-2019 characterizing the Basel III phase-in arrangements. Balance-sheets and income statements are expressed on an annual basis and in Euro.

Our objective is to assess the behavior of commercial banks under a regulatory regime *à la*

[17]This implies that $r''_K > 0$.

[18]Note that under these conditions, the elasticities are only positive if $L > -2 \cdot \dfrac{r'(L)}{r''(L)}$.

[19]For further details on the hypotheses set in the empirical literature, see Berger & Bouwman (2009).

Basel III. Thus, we cover banks implied in the intermediation activity only, i.e, banks granting loans to non-financial agents, including commercial, cooperative, and savings banks. We exclude entities such as central banks, investment banks, and banks granting loans for predetermined sectoral activities.[20]

We select bank entities at the group level and under a consolidated format only. First, it allows avoiding double-counting issues by removing subsidiaries from the sample. Second, the literature shows that using data under the consolidated format allows to truly reflect the behavior of the bank.[21] Moreover, capitalization is usually measured at the group level. The adoption of liquidity standards is also subject to this type of adjustment. Thus, measuring at the group level reflects the entity's exact capital and liquidity positions.

In addition, as illustrated in Kim & Sohn (2017), banks might be constrained by various mandatory and discretionary supervisory actions. Including banks satisfying no regulatory standards could also bias our estimations as their lending behavior might be regulatory-driven.

Following these criteria, our final sample is mainly composed of major banks in the Western European region. These banks are considered systemic (Global or Domestic) and represent a potential threat to financial stability.[22]

Table 1 provides the summary statistics of the sample. Loan growth appears low for Cyprus and Luxembourg, especially which does not necessarily reflect the economic-induced lending activity as these two countries are considered as financial centres.[23] The size of the banking systems remains heterogeneous across countries. However, due to the small number of banks per country (e.g., Luxembourg and Malta), it is difficult to argue for comparability purposes.

Capitalization is relatively homogeneous in the sample ranging from 10.45 for Luxembourg (N=1) to 23.64 for Sweden (N=5), and might reflect the ability of banks to comply with the capital requirement. It is less costly for banks to adjust to this ratio because the implementation

[20] For instance, this is the case for the automotive sector.

[21] See for example, Brei et al. (2013).

[22] See for example, EBA (2020) for a sample of systemic banks.

[23] For a classification of financial centres, see for example Lane & Milesi-Ferretti (2011).

of such a standard has been well established since its first implementation in 1988. Banking staff is highly qualified and well organized to clear the hurdle.

On the other hand, banks' funding differs widely across countries ranging from 10.45 for Ireland (N=1) to 199.77 for Malta (N=1).[24] This might be due to the novel aspect of the regulation. Banking adjustment remains relatively costly as banks train highly qualified staff and experiment different optimization strategies. This result might also be due to the bank reporting process. However, liquidity adjustments differ across the two measures of Basel III. Liquid assets remains available at low cost.

European banks are not featured by high levels of profitability. This might be due to the macroeconomic context characterized by weak growth. Finally, the provision and NPL ratios show that the screening function of banks is different across countries. Greece and Cyprus appear as the most impaired systems. This result is consistent with what was observed during the crisis. The heterogeneity of the loan quality indicators might represent an additional pressure on financial stability at the European level not national only.

We adjust our sample for potential outliers. The sample shows that outliers appear for capital and funding ratios above 30% and 300%, respectively. Banks above these thresholds are likely to reflect public capital injections and mergers and acquisitions (M&A) activity.[25] We remove observations with capital and funding ratios higher than 30% and 300% respectively, in order to avoid spurious lending behavior.

Our final sample consists of 91 banks for the 2011-2019 period.

[24] The range remains important after removing financial centres (73.6).

[25] The literature on the bank lending channel shows that other criteria are used to control for the M&A activity. However, these studies use large dataset mainly, including non-European banks. Regarding the size of our sample, we do not employ these types of adjustments.

Table 1: Average bank features for European systemic banks, by country (2011-2019)

Country	No. of banks	Loan Growth (%)	Size	Capitalization (%)	Funding (%)	Liquidity (%)	Profitability (%)	Loan quality (allowances, %)	Loan quality (non-performing loans, %)
Austria	9	4.02	13.05	15.86	86.93	18.73	0.43	3.46	5.68
Belgium	1	2.17	12.50	18.50	107.26	21.62	0.66	3.54	8.08
Cyprus	2	-7.10	10.48	14.58	128.36	26.85	-1.07	18.00	51.05
Germany	11	0.65	14.86	16.62	97.13	15.34	0.17	0.88	1.90
Denmark	5	5.01	14.07	19.04	95.94	34.71	0.62	3.86	4.65
Spain	9	2.90	14.81	14.64	100.98	14.19	0.48	3.96	7.20
Finland	5	-0.19	13.55	17.89	116.16	14.41	0.45	0.34	1.08
France	4	1.35	15.55	15.42	91.35	38.12	0.23	3.09	5.35
United-Kingdom	9	1.77	15.54	19.90	107.52	19.63	0.62	0.97	2.43
Greece	4	-2.47	12.60	14.06	89.79	11.13	-1.40	18.01	38.64
Ireland	1	-3.83	11.79	15.91	10.45	28.74	0.19	5.10	12.90
Italy	19	1.59	14.63	14.65	90.05	14.94	0.07	5.49	13.49
Luxembourg	1	-7.48	8.88	10.45	116.23	9.87	0.28	1.80	2.88
Malta	1	2.18	9.14	17.21	199.77	24.22	0.81	3.39	5.39
Netherlands	3	-0.66	14.52	20.31	79.91	18.14	0.39	1.30	2.49
Portugal	2	-3.40	11.47	13.52	116.15	6.94	0.16	6.74	6.67
Sweden	5	3.43	13.62	23.64	42.56	17.18	0.72	0.29	0.47

Note: Loan growth corresponds to the sum of the lending growth rates of individual banks per country and is averaged for the period 2011-2019.
Size is calculated by computing the log of the total assets of the country (sum of the total assets of each bank of the country) and averaged for the period 2011-2019.
Capitalization corresponds to the sum of the TCRs of individual banks per country and is averaged for the period 2011-2019.
Funding corresponds to the sum of the funding ratios (customer deposits to net loans expressed in %) of individual banks and is averaged for the period 2011-2019.
Liquidity corresponds to the sum of the liquidity ratios (sum of cash, trading securities and interbank lending of maturities less than three months, divided by total assets, expressed in %) of individual banks and is averaged for the period 2011-2019.
Profitability corresponds to the sum of the ROA (%, after tax) of individual banks and is averaged for the period 2011-2019. Allowances corresponds to the sum of the allowance ratios (allowance for credit losses to gross loans) of individual banks and is averaged for the period 2011-2019.
Non-performing loans corresponds to the sum of the NPL ratios (non-performing loans to gross loans) of individual banks and is averaged for the period 2011-2019.

3.2 Econometric Methodology

In this section, we investigate the impact of the capital and funding ratios on the volume of loans granted by the bank. A simplistic method to check the effects of the ratios on lending is to regress lending L on CRR and LRR. The baseline specification of the econometric model to estimate is the following:

$$L_{i,j,t} = \beta_{CRR}\, CRR_{i,j,t-1} + \beta_{LRR}\, LRR_{i,j,t-1} + \epsilon_{i,j,t}, \tag{14}$$

where i denotes the bank, t the period and j the country where the bank operates.

We define the dependent variable $L_{i,j,t}$ as the ratio of net loans to total assets. The capital and funding ratios are denoted $CRR_{i,j,t-1}$ and $LRR_{i,j,t-1}$. They correspond to the capital and funding positions of bank i at time $t-1$ in country j, respectively.

We showed that the funding ratio corresponds to the ratio of capital plus the deposit-to-credit ratio. Thus, estimating model (14) would be misleading because the proper impact of the capital and funding ratios on lending is not fully identified.

Substituting LRR into eq. (14) suggests estimating the following model:

$$L_{i,j,t} = (\beta_{CRR} + \beta_{LRR})\, CRR_{i,j,t-1} + \beta_{LRR}\, \frac{D_{i,j,t-1}}{\theta_{i,j,t-1} L_{i,j,t-1}} + \epsilon_{i,j,t}, \tag{15}$$

Eq.(15) shows that the magnitude of CRR is capital and liquidity-induced. The proper impact related to the funding ratio is measured by the deposit-to-credit ratio $\frac{D_{i,j,t-1}}{\theta_{i,j,t-1} L_{i,j,t-1}}$, i.e, a proxy for the ratio of transformation. In more detail, we precisely estimate the impact of the funding ratio taking into account the volume of net loans to the denominator and not gross loans. This allows us to account for the function of screening measured by θ in section 2 and in eq.(14) and eq.(15).

Eq.(15) states that implementing a funding ratio such as the NSFR puts an additional pressure on the bank's capital position. In other words, implementing a prudential regime that is only capital-driven constraints the bank to satisfy a certain funding profile. This additional pressure gives incentives to the bank to improve its funding position via collecting an additional source of stable funding (retail deposits).

Eq. (15) can be rewritten as follows:

$$\Delta L_{i,j,t} = \beta_1 \, CRR_{i,j,t-1} + \beta_2 \, CFUND_{i,j,t-1} + \epsilon_{i,j,t}, \tag{16}$$

where:

$CFUND_{i,j,t-1} = \dfrac{D_{i,j,t-1}}{L_{i,j,t-1}};$

$\beta_1 = \beta_{CRR} + \beta_{LRR}$;

$\beta_2 = \dfrac{\beta_{LRR}}{\theta} \Rightarrow \beta_{LRR} = \theta \cdot \beta_2;$

We deduce: $\beta_1 = \beta_{CRR} + \theta \cdot \beta_2$

Assuming that $\beta_{CRR} > 0$, $\beta_2 > 0$ and $\theta > 0$, we obtain $\beta_1 > \beta_2$.

Working hypotheses

We showed that implementing a capital ratio allows the bank to satisfy a certain funding profile. Our study highlights the need to disentangle the effects of the capital and funding standards to assess their proper impact on bank lending. Otherwise, regressing the two regulatory measures on bank lending would be misleading as the statistical relationship is not fully identified.

Based on eq.16, we assume that the amplitude of the coefficient on capital is greater than the one related to the deposit-to-loan ratio taking into account the definition we set in sections 2 and 3.

Hypothesis 1. *The sensitivity of loans to the funding structure, measured as the ratio of deposit-to-loans, is positive.*

Hypothesis 2. *The sensitivity of loans to capital is stronger than the one related to the bank's funding structure.*

In addition to account for the impact of the capital and funding requirements on bank lending, we consider other determinants of bank loan supply established in the empirical literature.

First, we include a set of determinants related to the specific characteristics of the bank. Liquidity is an important determinant of bank lending (see, e.g., Cornett et al. (2011); Brei et al. (2013); Kim & Sohn (2017); De Young et al. (2018)). In this study, we define the liquidity ratio (LIQ, %) as available in Orbis, which corresponds to the sum of cash, trading securities, and interbank lending of maturities less than three months, divided by total assets. This ratio is close to the LCR and differs from the funding measure that we specify in this model. We expect a positive impact of liquidity on lending as banks strengthening their liquidity positions are able to offer more loans.

Second, bank lending behavior might be different depending on the size of the bank (see, e.g., Gambacorta & Marques-Ibanez (2011); Kim & Sohn (2017); De Young et al. (2018); Ben Naceur et al. (2020)). Following Kim & Sohn (2017), two competing sets of hypotheses emerge in the literature. First, the too-big-to-fail theory states that banks may increase loans as they benefit from an implicit insurance as too-big-to-fail institutions. On the other hand, large banks can invest in assets different from loans for diversification purposes. We express the size of the bank as the log of total assets ($SIZE$, $ln\, TA$).

Bank profitability is also an important determinant of bank loan supply. According to Kim & Sohn (2017), banks with high profitability can offer a greater amount of loans as the quality and quantity of their capital ratios improve. On the other hand, higher profitability might reflect a higher risk on the asset choice of the bank. Thus, banks might offer fewer loans to restore the quality of assets. We employ the return on assets (ROA, %) which corresponds to the net income to total assets.

Francis et al. (2009) and Kim & Sohn (2017) show that loan quality is an important determinant of bank lending. First, we use the ratio of loan loss reserves to gross loans (PRO, %) that the bank disposes of to countervail effective loan losses. This ratio corresponds to a forward measure of the bank decision problem while the second measure, the non-performing loan ratio (NPL, %) corresponds to a backward measure of loan quality. NPL corresponds to non-performing loans to net loans. We expect a negative sign of the coefficients on loan quality. Lending decreases as the quality of the loan portfolio worsens.

The second type of determinants relates to the economic and monetary environment of the bank. We employ the growth rate of real GDP (ΔGDP, %) to account for economic conditions which usually controls for the demand of credits in the literature (see, e.g., Francis et al. (2009); Brei et al. (2013); Kim & Sohn (2017); Ben Naceur et al. (2020). Second, monetary conditions are also important as they reflect the cost of granting additional loans. We define the yield ($YIELD$) as the difference between the long and short-term interest rates, which also reflect the stance of monetary policy. Macroeconomic data are chosen from the IMF World Economic Outlook database and the OECD statistics.

We estimate the following econometric model:

$$\Delta L_{i,t} = \alpha_i + (\beta_{CRR} + \beta_{LRR})\, CRR_{i,t-1} + \beta_{LRR}\, \frac{D_{i,t-1}}{\theta_{i,t-1} L_{i,t-1}} + \gamma\, X_{i,t-1} + \theta\, Z_{j,t-1} + \epsilon_{i,t}. \tag{17}$$

We employ the panel OLS estimator, including fixed-effects at the bank level. As in Kim & Sohn (2017), we include fixed-effects in our estimations in order to account for other determinants at the bank level. In addition, as argued in Brei et al. (2013), we use fixed-effects because our sample is not drawn randomly.[26] All variables are lagged once in order to avoid endogeneity issues.[27]

Table 2 describes the variables and summary statistics employed in the study.

[26]The Haussmann test confirms that a fixed-effects model is preferred.

[27]See Brei et al. (2013) and Kim & Sohn (2017) for a justification.

Table 2: Definition and Summary Statistics

Variable	Definition	Observations	Mean	Std. Dev	Min	Max
Dependent variable						
$L_{i,j,t}$	Growth rate of Net Loans to Total Assets (%)	693	0.24	4.88	-27.27	31.76
Bank-specific characteristics						
$TCR_{i,j,t}$	Capital ratio (%)	697	16.30	4.12	-5.00	29.54
$LRR_{i,j,t}$	Customer funding ratio (%)	697	93.97	38.75	8.42	297.11
$LIQ_{i,j,t}$	Liquidity ratio (%)	697	18.28	12.43	1.04	61.57
$SIZE_{i,j,t}$	Logarithm of total assets	697	11.08	1.85	6.71	14.63
ROA_{t-1}	Return on assets (%)	696	0.20	1.16	-13.41	4.43
$ALLOWt-1$	Allowance for credit losses to gross loans (%)	696	4.27	5.13	-6.26	31.95
NPL_{t-1}	Non-Performing Loans to gross loans (%)	679	8.38	10.46	0.00	65.60
Macroeconomic controls						
$YIELD_{t-1}$	Short-term and Long-term difference	673	2.30	2.51	0.08	21.93
GDP_{t-1}	Growth of real GDP (%)	697	1.17	2.30	-9.13	25.12

[1] The capital ratio is negative for banks subject to recapitalization. However, this case remains insignificant in the sample.

[1] The highest value for $TERM$ corresponds to Greece.

4 Results

In this section, we discuss the results from the linear relationship between bank loan supply and its determinants.

First, we find that our variables of interest, i.e. the capital and funding ratios, exert a statistically significant and positive impact on bank lending. A one percentage point increase in the capital ratio is roughly associated with an increase of loans by 0.2 %. The positive impact of capital on lending suggests that the Basel III measures strengthened the lending structure of European systemic banks and had no deleterious effects on their lending capacities.

We find that the coefficient of funding has a positive impact on bank lending. Banks strengthening their funding profile tend to support lending by less than 0.1%. The magnitude of the funding coefficient remains weak relative to the capital one, as predicted in the theory. Clearing the capital standard allows satisfying a certain funding profile. However, this might be insufficient and applying an additional requirement on funding appears necessary.

Overall, these two results are consistent with our theoretical predictions. Clearing and increasing the capital and funding positions allows extending the business opportunities of the bank, such as lending, which is also consistent with the risk absorption hypothesis set in the empirical literature.

Second, all coefficients related to other bank-specific characteristics are generally significant with expected signs. The impact of the liquidity ratio is positive, and the magnitude is as consistent as the capital ratio. This result is in line with the literature (see, e.g., Cornett et al. (2011); Brei et al. (2013); Kim & Sohn (2017); De Young et al. (2018)) and highlights the importance to consider the liquidity profile of the bank in supporting loan supply. Moreover, this result shows that completing the capital and funding ratios with a liquidity requirement such as the LCR has no detrimental effect on bank loan supply.

Size remains an important determinant of bank loan supply. This study lends support for the too-big-to-fail theory as specified in Kim & Sohn (2017). In particular, the positive sign of the coefficient suggests that the effect of moral hazard behavior derived from the too-big-to fail theory prevails. Thus, particular concerns on financial stability in Europe might be addressed through the behavior of European banks defined as too-big-to fail.

The quality of the loan portfolio is also an important determinant to take into account for bank loan supply. The loan loss reserve ratio has a positive impact on bank loan supply and its magnitude is relatively large. The ratio of non-performing loans is significant and negative. A one percentage point increase in the NPL ratio is associated with a decrease of loans by less than 0.2 % approximately.

Finally, macroeconomic determinants are significant, meaning that economic and monetary conditions are important determinants of bank loan supply during the phase-in period. Consistent with the literature (see, e.g., Francis et al. (2009); Brei et al. (2013); Kim & Sohn (2017); Ben Naceur et al. (2020), we find that the real GDP growth has a positive impact on bank loan growth.

The yield, i.e., the difference between the long and short-term interest rates, is highly significant and large in magnitude. The positive impact of the coefficient suggests that bank loans tend to grow as the yield deepens. This result suggests that a rise in the yield might reflect the downward dynamic of the short-term interest rates.[28]

[28] Other empirical specifications have been tested. However, we do not find evidence of interaction effects or non-linear capital relationship. Robustness checks conducted in appendix show that the TCR and LRR exert a statistically and positive impact on bank lending. These estimations are based on the GMM methodology. Other determinants remain significant especially on the loan quality portfolio.

Table 3: Baseline Results

VARIABLES	R1	R2	R3	R4
TCR_{t-1}	0.251***	0.140	0.159*	.
	(0.0918)	(0.0875)	(0.0905)	.
$T1_{t-1}$	.	.	.	0.216**
	.	.	.	(0.107)
LRR_{t-1}	0.0536***	0.0359*	0.0500**	0.0507**
	(0.0171)	(0.0185)	(0.0229)	(0.0227)
LIQ_{t-1}	.	0.153***	0.152***	0.149***
	.	(0.0399)	(0.0438)	(0.0431)
PRO_{t-1}	.	0.282	0.647***	0.640***
	.	(0.248)	(0.174)	(0.173)
NPL_{t-1}	.	-0.00790	-0.147*	-0.148*
	.	(0.116)	(0.0779)	(0.0784)
ROA_{t-1}	.	-0.0792	-0.318	-0.371
	.	(0.282)	(0.263)	(0.265)
$SIZE_{t-1}$	.	6.400***	6.565***	6.264***
	.	(1.722)	(1.708)	(1.750)
$YIELD_{t-1}$	.	.	0.430**	0.455**
	.	.	(0.207)	(0.206)
GDP_{t-1}	.	.	0.279*	0.280*
	.	.	(0.147)	(0.145)
Observations	693	676	652	652
R-squared	0.060	0.140	0.168	0.172
N	91	90	87	87

Robust standard errors in parentheses.

(***, **, *) indicate significance at the 1%, 5%, and 10% level.

5 Conclusion and policy implications

In this paper, we investigate the impact of a regime *à la* Basel III for European systemic banks mainly. This topic is of particular interest as the possibility of a credit crunch scenario remains a debate of intensive research.

To our knowledge, this is the first paper drawing a theoretical model of bank behavior under a regulatory regime *à la* Basel III. Consistent with the novel aspect of this regulatory regime, we also contribute to the literature by building a new metric of bank funding to deeply investigate the implications of such a joint regulation on bank lending.

Our paper points to three major results. First, using a sample of 91 European banks, we show that Basel III had no deleterious effects on European systemic bank lending under the phase-in period. Instead, the possibility of a credit crunch scenario is likely due to the quality of the loan portfolio rather than the implementation of more stringent rules on capital and liquidity. This result lends support for the core of hypotheses related to the risk absorption capacity of banks, as stated in Berger & Bouwman (2009).

Second, based on our new metric of funding, we find that implementing the NSFR strengthens the positive impact of bank capital on lending. In addition, we find that collecting stable funding sources such as customer deposits favors the lending capacity of European systemic banks. More specifically, it appears that European systemic banks raise their risk absorption capacities under a regulatory environment *à la* Basel III.

Third, regarding the rise of the banking regulation complexity, we find no cross-effects that might dampen the European systemic banks' bank lending capacity. This result suggests that the incentives set by prudential authorities are entirely fulfilled. While more stringent rules on capital strengthen the credit structure of this type of banks, the adoption of the NSFR incentives banks to sound and sustainable liquidity management practices without detrimental effects on lending. This result suggests that the two ratios appear as complements rather than substitutes at the microeconomic level.

Our paper let an avenue for future research. First, as argued in Ben Naceur et al. (2020) and De Young et al. (2018), bank size remains an important determinant of bank lending. Investigating the costs induced by a regime *à la* Basel III for small and medium banks would allow to deeper investigate the impact of this type of measure on bank lending. This lends consideration for the design of the regulatory policy as its objective is to promote financial stability without impeding lending, which remains central to the promotion of economic growth in Europe. Second, in the vein of Gambacorta & Marques-Ibanez (2011) and Gambacorta & Shin (2018), we underline the importance of the bank-specific characteristics under a joint regulation which lends further considerations for the comprehension of the bank capital channel and thus the common implications of the monetary and macroprudential policies.

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Appendix

Table 4: GMM estimations

VARIABLES	R5 Macro variables Estimator: D-GMM	R6 Macro variables Estimator: S-GMM	R7 Time Fixed-Effects Estimator: D-GMM	R8 Time Fixed-Effects Estimator: S-GMM
L_{t-1}	0.905***	0.970***	0.929***	0.970***
	(0.219)	(0.0949)	(0.130)	(0.0678)
TCR_{t-1}	0.110**	0.138**	0.0828**	0.0866*
	(0.0474)	(0.0657)	(0.0392)	(0.0465)
LRR_{t-1}	0.105**	0.0471	0.0530	0.0273
	(0.0508)	(0.0576)	(0.0705)	(0.0400)
LIQ_{t-1}	0.0566**	0.0265	0.0401**	0.00674
	(0.0261)	(0.0361)	(0.0182)	(0.0337)
PRO_{t-1}	0.202**	0.106**	0.119***	0.0941**
	(0.0815)	(0.0510)	(0.0415)	(0.0450)
NPL_{t-1}	-0.159**	-0.106**	-0.0953**	-0.103***
	(0.0734)	(0.0438)	(0.0474)	(0.0384)
ROA_{t-1}	-0.0157	-0.0252*	-0.00950	-0.00696
	(0.0137)	(0.0147)	(0.0132)	(0.0156)
$SIZE_{t-1}$	0.0945	-0.0622*	-0.0145	-0.0620*
	(0.153)	(0.0348)	(0.198)	(0.0358)
$YIELD_{t-1}$	0.0157**	0.00238	.	.
	(0.00795)	(0.00890)	.	.
GDP_{t-1}	0.00582	-0.00109	.	.
	(0.00506)	(0.00421)	.	.
Observations	553	641	574	665
Number of banks	87	87	90	90
AR(1) (p-value)	0.0190	0.00501	0.00866	0.00399
AR(2) (p-value)	0.708	0.771	0.742	0.643
Hansen (p-value)	0.296	0.434	0.160	0.308
Number of Instruments	56	71	63	78

Note: This table shows the estimates of equations 12 and 13 using the GMM methodology. All variables are expressed in logs and lagged once.

Robust standard errors in parentheses.

(***, **, *) indicate significance at the 1%, 5%, and 10% level.