

Lower bank capital requirement as a policy tool to support credit to SMEs: evidence from a policy experiment¹²

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Abstract: Starting in 2014 with the implementation of the European Commission Capital Requirement Directive, banks operating in the Euro area were benefiting of a 25% reduction (the supporting factor or “SF” hereafter) in own funds requirements against SME loans. We investigate empirically whether this reduction has supported SME financing and to which extent it is consistent with SME credit risk. Economic capital computations based on multifactor models do confirm that the capital requirement should be lower for SMEs. Taking into account the uncertainty surrounding their estimates and adopting a conservative approach, the SF is consistent with the difference in economic capital between SMEs and large corporates. The probability of an extension of credit as well as the probability of obtaining a new loan are both positively affected by the eligibility to the SF. Moreover, the SF has an unintended consequence in the form of rationing relatively more marginally ineligible firms.

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¹ The opinions expressed in the paper represent the authors’ personal opinions and do not necessarily reflect the views of the ACPR - Banque de France or their staff.

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1. Introduction

SME financing is a growing concern in Europe. While SMEs are a main engine of growth in Europe, they are still today largely dependent of banks for their external financing. By contrast to bank lending towards large corporates, bank lending to SMEs remains in 2017 below its pre-level crisis. Monetary or targeted fiscal policies are part of the usual toolkit available to policy makers in order to improve SME access to credit in time of crisis.³ In a context of rising banks' capital requirements, banks' lending decision became more sensitive to capital requirements, as illustrated by recent contributions to the empirical literature.⁴ In this paper, we investigate the effectiveness of a new tool used by policy makers to ease SME access to bank credit: the reduction of bank capital requirement associated to SME loans.

In 2014, the European transposition into EU law of the Basel III standards has introduced a 25% reduction in capital requirement –labelled a “supporting factor”- for exposures to SME. The European legislators require credit institutions to use this capital relief for the “exclusive purpose of providing an adequate flow of credit to SMEs established in the Union”.⁵ As stated by the legislators themselves, this reduction needs to be regularly assessed according to two criteria: an easier access to credit for SMEs and a consistency of capital requirements for SME credit risk. Using this policy experiment and taking advantage of the French credit national register providing a quasi-exhaustive sample of loans granted to corporate businesses operating in France, we provide such assessment. The credit impact of the reform is assessed through a difference-in-difference approach exploiting the discontinuity introduced by the reform at the €1.5 mln exposure threshold. The risk impact is gauged through the computation of banks' economic capital using the structural credit risk framework underlying the computation of the regulatory risk based capital requirement.

³ During the financial crisis targeted monetary policy such as the TLTRO or the ACC were implemented in Europe. In France, SME benefits from specific fiscal deduction on their investment plan.

⁴ See for instance Behn et al. (2016) or Fraisse et al. (2017) respectively in the case of Germany and France.

⁵ See paragraph 44 of the [Capital Requirement Directive published in the Official Journal of the European Union the 27 June 2013](#).

For being eligible to the capital reduction, the SME must display an annual turnover lower than €50 million and a total exposure vis-à-vis a given banking group lower than €1.5 million. To assess the “credit” impact of the reform (we refer to this part as the “*credit*” analysis thereafter), we adopt a difference-in-difference approach on the sample of firms eligible to the supporting factor (“SF” hereafter). We define a control group made of SMEs with exposure above €1.5 million and a treatment group made of the rest of SMEs. Our analysis is focused on the extensive margin: we contrast the access to credit for these two groups before and after the implementation of the reform. Our main variables of interest will be the probability to get an extension of existing loan or the probability to obtain a new loan. For the “risk” impact of the reform (we refer to this part as the “*risk*” analysis thereafter), we adopt an approach at the aggregate level, measuring the effects of the reform on the economic capital that the banks would need to hold against loan unexpected losses at the portfolio level. Exploiting a multifactor model consistent with the theoretical framework underlying the regulatory computation of capital requirement (see Gordy, 2003), we proceed to the computation of the “economic” capital where firm size is a risk factor. We check whether the difference in “economic” capital covering eligible loans and non-eligible loans is consistent with the capital relief induced by the supporting factor.

What we find.

Regarding the “credit” analysis assessing the impact of the SF on the access to credit, we find that the SF tends to have improved access to credit for eligible firms. In particular, we show that compared with the period before implementation, the *relative* probability of eligible firms (i) to get an extension of existing loan is higher and (ii) the probability to get a new loan is also improved. The magnitude of these effects is non-negligible: +10% and +17% respectively. On top of that, we present evidence consistent with a possible adverse effect of the supporting factor. Contrasting the pre and the post reform period, we show that for ineligible firms, the probability to observe a decrease in the outstanding amount of existing loan (because of faster amortization or non-roll-over of maturing loans) is higher than for eligible firms. This can be explained by the fact that, by decreasing the

outstanding amount of credit of existing loan sufficiently, banks can try to get the 25% discount on all the outstanding amount of credit provided it passes below the threshold.

The computation of economic capital requirements based on an extension of the asymptotic single risk factor (ASRF) model to a multifactor framework and its comparison with Basel III regulatory capital requirements do confirm that the capital requirements should be lower for SME loans than for large corporates. Taking into account the uncertainty surrounding their estimates and adopting a conservative approach, the SF is consistent with the difference in economic capital requirements between SMEs and large corporates.

Literature review

This paper contributes to three strands of literature on banks' capital requirements. The first and the older strand is that of the relation between capital requirements and lending. This relation has been recently reassessed exploiting both the strong capital shortfall induced by the financial crisis and an easier access to granular data that allow controlling for demand and supply shocks. In this framework, recent papers tend to indicate a negative impact of higher capital requirements on credit distribution (see Fraisse *et al.* (2017) for France, Aiyar *et al.* (2014) for the UK, Jimenez *et al.* (2017) for Spain or Behn *et al.* (2016) for Germany). In contrast to these papers that focus on the impact of tighter capital requirements, our paper exploits a policy experiment explicitly implemented to support credit growth (1) through the effect of a targeted *decrease* in capital requirements (2).

The second strand of literature our paper relates to is that of the measure of risk of the banks loans portfolio. This strand starts from the Asymptotic Single Risk Factor (ASFR) model of Gordy (2003), which is also the foundation of the regulatory risk-weight functions for credit exposures in the *Internal Ratings Based Approach*. In this framework, the IRB risk-weights are driven by the probability of default, the firm size and the correlation of risk to a systematic factor. However, regulatory formulas do not take into account borrowers' heterogeneity and possible concentration effects coming from potentially correlated defaults across borrowers belonging to the same portfolio's segment and whose financial situation is driven by "sectoral" systematic risk factors which are specific to their groups (see

Dietsch *et al.* (2016) for a comprehensive overview of the existing empirical studies on the relationship between asset correlations and firm size). We contribute to the existing literature by explicitly taking account for concentration using a multifactor framework. We consider firm size as an additional systematic risk factor. The choice of size as risk factor is motivated by the supporting factor issue.⁶

The assessments of the SF within the framework of academic policy evaluation are scarce. The only paper we are aware of is Mayordomo and Rodrigues Moreno (2016). Most of their analysis relies on the European Commission Survey on Access to Finance of Enterprises (“SAFE”). In this survey, selected firm managers are asked whether they have been financially constrained when applying for a loan or a credit line. The authors use this information to check whether the implementation of the SF eases the access to credit. The eligibility to the SF is defined only through the “SME” status of the firm *e.g.* given a particular level of employees and turnover. They failed to reach a positive consensus about the impact of the SF reform and decided to display its consequences by exploiting heterogeneity within SME firms. They provide evidence that the SF effectively impacts positively the credit supply to SMEs, but only for the medium sized group within SMEs because of their lowest risk. The SF enables to alleviate credit constraint faced by this group, but not for the micro/small SMEs. Banks prefer to grant loans to the safest SME companies to reach the regulatory requirements with the less risky commitment. They also briefly provide an assessment of the impact of the SF on credit distribution using the Spanish credit register. Overall, they find that the SF seems to have increase provision of credit for eligible firms. We will discuss and contrast these results in more detail later in the paper.

Our paper contributes to these different strands of the literature, providing a new perspective, more exhaustive, with both an analytic examination of the consistency of the capital requirements associated to SME risks and an empirical evaluation of the effective impact of the SF on credit distribution to these firms. Our granular data enables us to precisely define the eligibility of a loan to the SF and

⁶ With respect to this strand of literature, our paper has also the benefit to exploit long time series of default rates of SMEs.

therefore allows for a more comprehensive answer about the impact and the legitimacy of the SF for France.

The remainder of the paper is organized as follows: Section 1 presents the institutional background and the detailed definition of the supporting factor. Section 2 describes the data and provides descriptive statistics. Section 3 presents our identification strategy. Section 4 contains estimates of the credit effect of the Supporting Factor. Section 5 provides a risk analysis comparing economic capital by firm size to the regulatory requirement induced by the supporting factor. Section 6 provides concluding remarks.

2. Institutional Framework

The article 501 of the Capital Requirements Regulation (CRR), implementing the Basel III standards into EU law, introduces a deduction in the capital requirements for exposures to SMEs, through the application of an "SME Supporting Factor" equal to 0.7619 (8%/10.5%). The aim is to compensate the increase in capital requirements for credit exposures to SMEs through Basel III higher capital ratios (from 8% to at least 10.5%) and the tighter capital definition associated. SME lending is a salient political issue in Europe. This capital deduction reflects the policy wills that SMEs should not suffer from the consequences of a financial crisis they are not responsible for.⁷ The directive came into force the 1st January 2014.

The identification of SMEs is precisely defined by the 2003 European Commission Recommendation, Annexe 2 as following. *"The category of micro, small and medium-sized enterprises (SMEs) is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding € 50 million or an annual balance sheet total not exceeding € 43 million."* Among these criteria, the CRR indicates that only the annual turnover must be considered to qualify a company as an SME allowed to benefit from the Supporting Factor.

⁷ "SMEs are the backbone of the European economy, providing a potential source for jobs and economic growth" European Commission : "Regulation of the European Parliament and of the Council", 2015.

The CRR also brings precisions about exposures in question. "*The total amount owed to the institution and parent undertakings and its subsidiaries, including any exposure in default, by the obligor client or group of connected clients, but excluding claims or contingent claims secured on residential property collateral, shall not, to the knowledge of the institution, exceed € 1.5 million. The institution shall take reasonable steps to acquire such knowledge.*" Likewise, the CRR refers to the amounts "owed" to the institution. Therefore, in the case of a credit line, only the drawn amount needs to be considered when checking if the € 1.5 million limit is complied with. Provided that all conditions are met, the exposure as a whole including its undrawn part can qualify as exposure to an SME and benefiting from the capital relief. We can note the difference between exposures considered for the eligibility to the Supporting Factor and exposures that will benefit from the capital requirements deduction (Supporting Factor enforcement). Indeed, only some exposures are taken into account for eligibility, whereas all exposures benefit from the capital requirements deduction. More precisely, off-balance sheet exposures and claims or contingent claims secured on residential property collateral must not be considered when assessing the amount owed and eligible to the Supporting Factor. However, the Supporting Factor, as deduction in capital requirements, applies to all the bank's exposures.

To sum up, to be qualified for the "Supporting Factor", firms must display (i) an annual turnover lower than € 50 million and (ii) a total amount of relevant exposures within a banking group lower than € 1.5 million.

3. Data and Descriptive Statistics

We exploit the French national credit register available at the Banque de France (called "Centrale des risques"). This register collects quasi-exhaustively the bilateral credit exposures of resident financial institutions, or "banks", to individual firms on a monthly basis. A bank has to report its credit exposure to a given firm as soon as its total exposure on this firm is larger than € 25,000. This total exposure includes not only funds effectively granted to the firm (or drawn exposures), but also the bank's

commitments on credit lines (or undrawn exposures) and guarantees, as well as specific operations (medium and long-term lease with purchase option, factoring, securitized loans, etc...). Firms are defined here as legal units (they are not consolidated under their holding company when they are affiliated with a corporate group) and referenced by a national identification number (called a “SIREN” number). They include single businesses, corporations, and sole proprietors engaged in professional activities.

The credit register also provides information on the size and the credit risk of borrowing firms on the firms that have a turnover above € 0.75 million. Indeed, the Banque de France estimates internally its own credit ratings for a large population of resident firms. These ratings are used by banks to evaluate whether loans to firms are eligible as collateral to the refinancing operations within the Eurosystem. The two analyses are run using this common dataset but they are subject to slightly different treatments that we detail just below. Note however, that in both cases we apply the following restrictions: i) we exclude exposures toward the financial sector and ii) we exclude exposures toward individual entrepreneurs.

For our “risk” analysis, we need to restrict ourselves to the sample of firms which fulfill four conditions: i) they have exposures in the French Credit Register⁸, ii) the Banque de France (BdF) rating department gives them a rating (including default grades), iii) they obtain loans from at least one large banking group operating in the French loans to businesses market, and iv) their annual turnover is over € 0.75 million. The population contains more than 3 million of observations over the period. The sample is very representative of the French businesses population and of the SME population with turnover over € 0.75 million in particular.⁹ The Banque de France estimates that its

⁸ In France, every bank should declare business loans provided that the loan amount is over EUR 25,000 starting from 2006. However, before 2006, this threshold was EUR 75,000. To avoid creating artificial entries of firms in 2006, we apply the €75,000 threshold over the entire sample period considered, *i.e.* 2004-2015.

⁹ In fact, each firm with a turnover value over € 0.35 million euros is rated by the Banque de France ratings system provided that this firm receives a bank loan with an amount of at least 25.000 euros. So, for the French population of “borrowing” firms with turnover over € 0.75 million, the rate of coverage should be close to 100%.

database containing all accounting information (Centrale de Bilans Fiben) represents at least 75 percent of the turnover of the population of French firms.¹⁰

The French database ranges from 2004 to 2015 (over 66 quarterly observations). Figure 1 depicts the time series rates of defaults. It shows a clear dependence of defaults rates to the business cycle. Figure 2 illustrates the difference of default rates when taking account for difference in ratings.

For our “credit” analysis, we are not restricted by the availability of the credit risk rating. We run the analysis over the period 2009-2016, *i.e.* 5 years before the entry into force of the SF (the *pre* period) and 3 years after (the *post* period). Note that for the purpose of identifying eligible exposures, we aggregate them at the firm-banking group-quarter level. As we suspect that the credit effect of the SF might be seen on very small firms as well, we do not restrict the sample to firms with available information regarding the credit rating. As a result, we end up with an extremely large dataset (almost 55 million of observations). For computational purpose, we draw a random sample representing 5% of the firms present in this dataset.

In this paper, we want to explore the potential effect of SF on credit distribution at the extensive margins *i.e.* the probability to observe the creation of new loans or the destruction of existing loans. For this purpose, we recreate the, unobserved, zero exposure: for each pair of bank-firm, we recreate a zero exposure at the beginning and at the end of the reported lending relation between the bank and the firm. Most of the time it corresponds to the upper bound and the lower bound of our sample, *i.e.* 2009-Q1 and 2016-Q4, but it could sometime happen in the middle of the sample. With these additional observations, we are able to identify the extensive margins. Finally, because of the Great Financial Crisis, a lot of lending relations were destroyed for few months and then recreated. It is particularly the case in 2009. This creates somehow a spike in the creation of loan. We thus ignore the year 2009 and our period of analysis covers 2010-2016.

¹⁰ See Banque de France, 2016, rapport de l’Observatoire des délais de paiement, appendix 5.

4. Empirical Strategy

4.1 The effect of the supporting factor on banks risks portfolio

To assess the risk increase induced by the SF, we use the structural credit risk approach as devoted by Merton. In this section we provide a short description of this framework and describe how we apply it for our risk analysis.

In the Merton framework, losses at the sub-portfolio level are defined as the sum of losses on defaulting loans. Thus, if u_i is defined as the loss given default (LGD) of obligor i and Y_i is the default indicator variable of obligor i (Y_i takes the value of 1 if there is a default and 0 otherwise), total portfolio losses L are given by

$$L = \sum_{i=1}^n u_i Y_i$$

In structural credit-risk models, default occurs if the financial health of borrower i crosses a default threshold. Here, financial health is represented by a latent (unobservable) variable U_i , which is determined by the realizations s of a set of S multivariate Gaussian systematic risk factors with loadings w_i and correlation matrix R , and the realization of a standard normal specific factor ε_i . Denoting Φ the standard normal cdf, default occurs when U_i crosses downwards a threshold calibrated from the borrower's historical default probability \bar{p}_i :

$$Y_i = 1 \Leftrightarrow U_i = w'_i s + \sqrt{1 - w'_i R w_i} \varepsilon_i < \Phi^{-1}(\bar{p}_i) \quad (1)$$

Thus, given a realization s of the systematic risk factors, Equation (1) can be rewritten such as a default occurs when:

$$\varepsilon_i < \frac{\Phi^{-1}(\bar{p}_i) - w'_i s}{\sqrt{1 - w'_i R w_i}}$$

As the borrower's specific risk factor is normally distributed, the default probability conditional to s is also standard normal. Moreover, assuming that specific risk can be entirely diversified away, losses

can be approximated by their expected value conditional to s (Gordy, 2003). Conditional portfolio losses are then defined by

$$L(s) \approx \sum_{i=1}^n u_i \Phi \left[\frac{\Phi^{-1}(\bar{p}_i) - w'_i s}{\sqrt{1 - w'_i R w_i}} \right] \quad (2)$$

This framework is known as the asymptotic multi-factor framework of credit risk (e.g., Lucas *et al.*, 2001) and is an extension of the asymptotic latent single risk factor (ASRF) model underlying the Basel 2 capital requirements for credit risk. Equation (2) assumes that each obligor can be characterized by his individual default threshold and factor sensitivities. However, in retail loan portfolios, default rates are generally computed based on rating grades, and sensitivities to risk factors cannot be computed on an individual basis. Thus, assumptions are required to reduce the number of parameters of the loss variable. A common assumption is that obligors who belong to the same rating j will share the same default threshold. Moreover, one could assume that the vector of risk factor sensitivities is the same for obligors sharing a set of common characteristics (here the firm size). Assuming that the portfolio is portioned in K segments, that credit exposures are rated using a scale with J grades, and denoting n_{kj} the number of exposures with rating j in segment k , losses can be rewritten as

$$L(s) \approx \sum_{k=1}^K \sum_{j=1}^J \sum_{i=1}^{n_{kj}} u_i \Phi \left[\frac{\Phi^{-1}(\bar{p}_j) - w'_k s}{\sqrt{1 - w'_k R w_k}} \right] \quad (3)$$

The calibration of this credit risk model requires the estimation of J default thresholds $\Phi^{-1}(\bar{p}_j)$ of the rating scale, the factor loadings w_k , and the correlation matrix R . A first order choice is the specification of the systematic risk factors. However, we are interested in capturing the heterogeneity or risk for firms of different sizes. Thus, we expand the latent factor approach underlying the ASRF model by considering a latent risk factor for each size class. These factors are possibly correlated, with correlation matrix R . In other words, we consider that credit risk within each portfolio size segment can be described by a single risk factor model, taking into account correlations of risk exposures

across segments. The different parameters are estimated using a binomial probit generalized linear mixed model (McNeil and Wendin, 2007). The generalized linear mixed model provides a straightforward econometric framework to estimate the parameters of our multifactor credit risk model. Indeed, the choice of this specification leads to considering the default thresholds as fixed effects and the factor loadings and factor correlations as described by a multivariate vector of Gaussian random effects.

Within the framework of GLMM models, the default probability in equation (3) is defined as follows. Let Y_t be an $(N \times 1)$ vector of observed default data at time t and γ_t be the $(K \times 1)$ vector of random effects. The conditional expected default probability of obligor i at time t is then:

$$P(Y_{it} = 1 | \gamma_t) = \Phi(x'_{it} \beta + z_i \gamma_t)$$

where $\Phi(\cdot)$ is the standard normal cdf¹¹, β denotes the vector of parameters associated with the fixed effect (the borrower's rating class) and z_i is the design matrix of the random effects, here an identity matrix with size the number of random effects. If the rating scale is properly built, we expect the β parameters that correspond to the default thresholds to be associated with the ratings to be ordered and to increase as credit quality decreases. $x'_{it} = [0, \dots, 1, \dots, 0]$ is a $(1 \times J)$ vector of dummies defining the rating of borrower i at time t .

Once the credit risk parameters are estimated, the distribution of losses at the portfolio level is computed by a Monte Carlo simulation¹¹, with each simulated realization of the systematic risk factors being converted into a conditional default probability at the rating/size segment level as defined by Equation (3) and, finally, into conditional expected losses at the portfolio level. Various quantile based on risk measures such as Value-at-Risk (VaR) or Expected Shortfall can then be retrieved from the simulated distribution of portfolio-wide losses.

¹¹ We focus on the probit link function because the normal distribution is the underlying link function that is assumed by the Basel II/III framework of credit risk.

Our multifactor model provides the economic capital necessary to cover losses of a portfolio of loans by firm size buckets. We use this model as a benchmark to check whether the capital deduction induced by the supporting factor on SME loans (about 25%) is consistent with the difference in economic capital between the SME loans and the rest of the corporate loans portfolio (the “large” corporate businesses).

4.2 The effect of the supporting factor on credit distribution

To assess the effectiveness of the SF in term of credit distribution, we rely essentially on a difference-in-difference framework. Our sample is made of SMEs, *i.e.* firms with a turnover lower than € 50 million and, as a result, the eligibility to the SF is only a function of the outstanding amount of eligible exposures (*i.e.* above or below the € 1.5 million threshold).¹²

Notation and conceptual framework

Denote by $L_{f,b,t}$ the total outstanding amount of credit received by the firm f from banking group (bank thereafter) b at time t . We will denote by $\tilde{L}_{f,b,t}$ the equivalent amount used to assess the eligibility to SF. Hence, we will also denote by $EL_{f,b,t}$ the eligibility variable:

$$EL_{f,b,t} = \begin{cases} 1 & \text{if } \tilde{L}_{f,b,t} < \text{€}1.5 \text{ mln} \\ 0 & \text{if } \tilde{L}_{f,b,t} \geq \text{€}1.5 \text{ mln} \end{cases}$$

Similarly, denote by $Post_t$ the variable indicating the period where the SF has entered into force:

$$Post_t = \begin{cases} 1 & \text{if } t \geq 2014Q1 \\ 0 & \text{if } t < 2014Q1 \end{cases}$$

According the article 501 of the CRR, once an exposure become eligible, starting from 2014-Q1, the capital requirements associated to this exposure benefit from a 25% discount. Importantly, the discount applies to the total amount outstanding, *i.e.* to the stock of credit. Said differently, from the

¹² We could have included non-SME firms and the eligibility criteria would have been two-folded : we could have compare SMEs and non-SMEs with an outstanding amount lower than € 1.5 million. We do not proceed in this way because we think that firms with a turnover higher than € 50 million are very different from SMEs, especially regarding their relation with bank lending (in particular, they have access to a lot of substitute to bank credit). This is why we limit the sample to SME and we discriminate across them using the threshold for eligibility.

first quarter of 2014, all exposures $L_{f,b,t}$ eligible to the SF (*i.e.* where $\tilde{L}_{f,b,t} < \text{€}1.5 \text{ mln}$) immediately benefit from the discount without any action from the bank or the firm.

The true incentive scheme provided by the implementation of the SF works at the margin: for each additional euro of lending, it will cost 25% less in term of capital requirements if this euro is lent to an eligible firm relative to an ineligible firm. Against this background, it follows that our main variable of interest will be the amount of *new credit* granted between t and $t + 1$, *i.e.* the change in the outstanding amount from one period to the following period :

$$\Delta L_{f,b,t} = L_{f,b,t+1} - L_{f,b,t}$$

It is worth noting that the implementation of the SF could also provide adverse and unexpected incentives to banks. There are two cases:

- when firm f has an exposure $\tilde{L}_{f,b,t}$ slightly below the € 1.5 million threshold, the bank b can be reluctant to extend additional credit to her the next period, in order to avoid passing the threshold and losing the 25% discount.
- when a firm f has an exposure $\tilde{L}_{f,b,t}$ slightly above the € 1.5 million threshold, the bank b can be reluctant to extend additional credit or to rollover existing one. In the worst case, and if possible, the bank can even accelerate the amortization of the loan. In both case, the goal is to lower the total outstanding amount taking into consideration for eligibility in order to benefit from the 25% discount in capital requirements.¹³

As a result, we investigate separately the positive and the negative changes in outstanding amount between two periods. The first one ($\Delta L_{f,b,t} > 0$) refers to the extension of an additional amount of credit on an already existing loan, while the second one ($\Delta L_{f,b,t} < 0$) refers to the amortization of the existing loan. This second one is less intuitive, but all the more important regarding the possible unintended consequences of the SF explained just before : in the case banks try to lower outstanding

¹³ At the margin, this latter effect could be very large given that, in the case of a firms having $\tilde{L}_{f,b,t} = \text{€}1,500,000$, a one dollar decrease of the exposure would provide a 25% discount on the capital requirements computed over the € 1,499,000.

amount of credit of marginally ineligible firms, it should translate by a relatively higher probability to observe a decrease in the outstanding amount of existing loan.

In this paper, we will first focus on the extensive margins, *i.e.* the probability to get an extension of credit and the probability to face an amortization of the loan:

$$\begin{cases} \mathbb{P}(\Delta L_{f,b,t} > 0 \mid L_{f,b,t} > 0) \\ \mathbb{P}(\Delta L_{f,b,t} < 0 \mid L_{f,b,t} > 0) \end{cases}$$

We expect that following the supporting factor introduction, firms with an exposure below the eligibility threshold to the SF are more likely to receive an extension of loan (provided it does not lead to pass the threshold) or a roll-over of its existing loan (leaving the outstanding credit amount relatively unchanged) preventing the outstanding amount to decrease. By focusing on the extensive margin, we avoid the thorny issue of scaling stock or flow variable of credit.¹⁴

Given this analytical framework, it is natural to extend it to the analysis of the creation of new loan relations (entry) and the destruction of existing relations (exit). An immediate issue relates to the sample of potential lending relation to consider. In the case of exit, it is quite straightforward: the population to consider is the population of bank-firm in relation at time t and that will end up with no relation in $t + 1$. However, in the case of entry, it is a bit more complicated. Formally, every firm can enter in relation with every bank at any period. However, the population size will explode. We adopt a much more restrictive definition: as soon as a firm and a bank are observed in relation at one period in the sample, we posit that they could be in relation at any time within our period under study: we thus re-create zero exposure for these unobserved relations. We can now define the two additional probabilities that will be examined:

$$\begin{cases} \mathbb{P}(L_{f,b,t+1} > 0 \mid L_{f,b,t} = 0) \\ \mathbb{P}(L_{f,b,t+1} = 0 \mid L_{f,b,t} > 0) \end{cases}$$

We can then write clearly our econometric specification (1) :

¹⁴ Indeed, firm eligible and ineligible have exposure of very different size and comparing them together can be less straightforward than it appears. This analysis at the intensive margin is still an ongoing work and will be included in future version

$$\mathbb{P}(\Delta L_{f,b,t} > 0) = \alpha + \beta \cdot EL_{f,b,t} \cdot Post_t + \gamma \cdot EL_{f,b,t} + \theta \cdot Post_t + \sum_t \mu_t \cdot 1_t + \sum_t \omega_f \cdot 1_f + \sum_t \rho_b \cdot 1_b + \epsilon_{b,f,t}$$

where :

- $\sum_t \mu_t \cdot 1_t$ denotes a set of time fixed effects

- $\sum_t \omega_f \cdot 1_f$ denotes a set of firm fixed effects

- $\sum_t \rho_b \cdot 1_b$ denotes a set of bank fixed effects

- $\mathbb{P}(\Delta L_{f,b,t} > 0)$ refers to the four distinct probabilities we have just defined.

In all these regression, the coefficient of interest is β . It tells us to which extent the change in the probability considered (extension vs amortization vs new loan vs terminated loan) evolves differently for eligible firms relative to ineligible firms after the implementation of the SF compared with the period before the implementation. We saturate regressions with firm, quarter, bank fixed effects to control for a lot of possible confounding factors. In some specification, we even include bank-time fixed effects. We also include rating and size fixed effects in all regressions. Note that parameters γ and θ are not reported due to collinearity with firm and time fixed effects, respectively.

By saturating the specifications with fixed effects, we narrow the identification. For instance, by including firm fixed effects, the coefficient is estimated within firm, *i.e.* by comparing for the same firm (i) the change in the probability to obtain a new loan as the eligibility status changes over time for the same bank (ii) the variation in the probability to obtain a new loan from two banks as the eligibility status differ across these two banks.

In all regressions, we cluster our standard errors at the firm level, *i.e.* we allow some dependence in the standard errors *within* firms but we consider that these standard errors are not correlated *between* firms.

5. Results

5.1 The effect of the supporting factor on banks risks portfolio

In this section, we present the estimates of the portfolio credit-risk parameters (default thresholds, random effects variances and correlations) for the size segmentation of the credit portfolio. To compute capital requirements, we assume a 45% Loss Given Default value (“LGD” hereafter) and a 99.9% quantile of the probability distribution function. These parameter values are those we find in the Basel II/III regulatory framework. All models are estimated using annual default rates. Since we are ultimately concerned with the calibration of capital requirements, we consider not only the credit-risk parameters estimates but also capital requirements dependent on these estimates. More precisely, we compare in each size class the ratio of capital requirements measured when using the multifactor model parameters with the ratio of capital requirements given by the regulatory Basel III formulas.

In what follows, Table 1 shows the random effect variances - which measure the exposure to systematic risk - and the correlations of the random effects provided by the GLMM model¹⁵.

Insert Table 1

Table 1 shows that the random effects across medium-sized and large firms size classes are highly correlated, with correlations ranging between 95% and 100%. However, correlations across small firms and medium-sized and large firms are negative or very small, showing a potential for diversification effects between these classes. Additionally, a joint equality test across random effects variances is rejected. Indeed, we observe that the larger firms are the most exposed to systematic risk, i.e., are the most exposed to general economic conditions, even if their default rates are low.

However, portfolio credit risk is not only determined by the degree of exposure to systematic risk but also by the default probabilities and the correlations across firms of different sizes, which are captured in the multifactor model by the correlations across random effects. The computation of economic capital ratios at the size segment allows precisely taking into account these different dimensions of

¹⁵ The estimation also yields 25 (5×5) default thresholds, not shown here for the sake of simplicity. As expected, these thresholds are ordered, reflecting the increasing likelihood of default for lower ratings, and statistically different from 0.

risk in a consistent way. Table 2 presents the value of the economic capital ratio given by the multifactor model by size segment. Concerning the regulatory capital requirements, we have considered two regulatory regimes: the standard Basel II/III IRB regime and the CRD IV/CRR regime including the SF impact.¹⁶ Table 2 also presents the two ratios which could be compared directly with the economic capital ratio.

Insert Table 2

We observe an increasing relationship between size and capital ratio in the three models. The level of capital requirements is far superior in the two regulatory models than in multifactor economic model, what shows a potential overestimation of capital requirements by the Basel II/III regulatory formulas or by the CRD IV/CRR regulatory formulas with a supporting factor. We consider here the large corporates capital requirements (that is corporates with a turnover of more than € 50 million) as a benchmark: this is motivated by the fact that the SF is deduction of capital requirement for SME loans with respect to no deduction of capital requirement for larger corporates. We compute the ratios of the two regulatory capital ratios relative to the economic capital ratio (last two columns of the Table 2) and we compare the values of these ratios between size classes. The difference in the ratios between size classes determines whether the size dependence of the regulatory capital requirements is consistent with that of the estimated economic capital requirements. Results in Table 2 confirm that the higher values of the ratios for small size classes reflect an overestimation of SMEs risk relative to large corporates in the two regulatory frameworks. In addition, results in Table 2 show the capital

¹⁶Under the Basel II/ III regime the regulatory capital requirement (for exposures on corporate) is computed accordingly to the following formula :

$$RW = \left(LGD \cdot N \left[(1 - R)^{-0.5} \cdot G(PD) + \left(\frac{R}{(1-R)} \right)^{0.5} \cdot G(0.99) \right] - PD \cdot LGD \right) \cdot (1 - 1.5 \cdot b)^{-1} \cdot (1 + (M - 2.5) \cdot b) \cdot 12.5 \cdot 1.06$$

$$\text{where : } R = 0.12 \cdot \frac{(1 - e^{(-50 \cdot PD)})}{(1 - e^{(-50)})} + 0.24 \cdot \left(1 - \frac{(1 - e^{(-50 \cdot PD)})}{(1 - e^{(-50)})} \right) - 0.04 \cdot \left(1 - \frac{\min(\max(5, S), 50) - 5}{45} \right)$$

and $b = (0.11852 - 0.05478 \cdot \ln(PD))^2$. RW denotes the risk-weight or the capital requirement, R the correlation, b an adjustment factor, S the total annual sales in millions. PD the probability of default, LGD , the loss given default, M the maturity, $N(x)$ is the cdf of a normal distribution $N(0,1)$ and $G(z)$ is the reciprocal of this cdf. Under the CRD IV/CRR regime, the RW is multiplied by the supporting factor for the eligible firms. For a conservative approach, every firm of a size class is given the upper bound of the turnover sales. For instance, firms belonging to the 7.5-15 class are given a € 15 million annual total sale. A similar IRB formula is provided for exposure on “other retail”, e.g. on firms with exposures lower than €1.5 million.

charge reduction provided by the implementation of the supporting factor. The ratio of the regulatory ratio related to the economic capital ratio is lower for the CRD IV/CRR model than for the Basel III model. Despite this reduction of the capital requirements, the ratio of regulatory capital to the economic capital remains largely higher for small and medium-sized firms than for large corporates.

There is obviously some model uncertainty in estimating economic capital. We start from table 1 displaying the random effect variance and consider values less favorable to a difference between SME and Large Corporate economic capital. We inflate the estimates of the random effect variance of the SME by two standard deviations¹⁷ and we decrease the estimate for the large corporate by two standard deviations ($0.225 - 2 * 0.07615 = 0.0727$). With this new set of random effects, we compute both the economic capital and the BIII regulatory capital. We find a ratio : *BIII regulatory capital / Economic capital* of 9.10% for the SME classes and of 6.47% for the large corporate class. In order to have the same economic capital ratio for the SME than for the large corporate than for the regulatory ratio, the SME should benefit from a 71% discount which is very closed to the SF calibration (76%).

In sum, economic capital computations do confirm that the capital requirement should be lower for SMEs. According to a multiple factor economic capital framework, the SF should be much higher than 25% in order to be consistent with the difference in economic capital between large and small firms. Nevertheless, taking into account the uncertainty surrounding the estimates of the multifactor models and adopting a conservative approach, the SF is consistent with the difference in economic capital between SMEs and large corporates.

5.2 The effect of the supporting factor on the distribution of credit

Following the econometric framework described in section 3.2, we run the specification (1). Precisely, we test the effect of being eligible to the supporting factor in the post period on (i) the probability to observe an increase in the outstanding amount of an existing exposures, (ii) the probability to observe a reduction in the outstanding amount of an existing exposures, (iii) the probability to observe the

¹⁷ For illustration : $0.0723 + 2 * 0.03602 = 0.1443$ for the 15-50 size class, $0.0163 + 2 * 0.0144 = 0.0451$ for the 5-15 size class and so on...

creation of a new relation and (iii) the probability to observe the destruction of an existing relation. We estimate the specification (1) using a *Linear Probability Model*. This choice is motivated by two considerations : first, we want to saturate our regressions with a full set of fixed effects which can become very tricky, if not impossible, in alternative econometric modelling (Probit...) and second, the results are very easily interpretable. Table 5 presents the results of these regressions.

Insert Table 5

In the two first columns, we observe that, when eligible to the supporting factor, a firm is significantly more likely to get an extension of credit (+1.2 ppts). This result is in line with what is expected from the supporting factor: at the margin, a one euro increase in lending costs 25% less in term of capital requirements when granted to eligible firms than to ineligible firms. In terms of magnitude, if we compare this 1.2 ppts increase to the unconditional probability of extension found in Table 4, panel C, it indicates that the probability of extension increases by roughly 10% after the introduction of the SF for eligible firms.

In the third and the fourth columns, the estimation of β indicates that when eligible vis-à-vis a given bank, the probability to observe a decrease in the outstanding credit amount is lower for eligible firms than for ineligible firms. This results can be explained in the following way: (i) either banks have some leeway to accelerate the amortization schedule of a loan (covenants), and try to use this option relatively more on ineligible firms after the SF implementation, possibly to lower the outstanding amount sufficiently to pass below the threshold of eligibility and obtain the 25% discount on all the outstanding amount (ii) or the eligible firms have a relatively higher probability to roll-over existing loan because of their eligibility preventing the outstanding amount to decrease. In both case, this results in a relatively lower (higher) decrease of outstanding amount of existing exposures for eligible (ineligible) firms. This effect has an order of magnitude of -0.2 ppts or -3%.

In column (5) and (6), the test is a bit different and requires some explanations. Here, we try to analyze whether the probability to obtain a new loan (*i.e.* the bank-firm relation has a zero exposure at t and a positive one at $t + 1$) varies relatively more after the implementation of the SF for eligible firms

compared with ineligible firms. However, starting from zero, all firms are eligible in a sense. What we test is the following hypothesis: given that a bank-firm relation has no exposure at time t , is the probability to obtain a new loan with an outstanding amount leaving the firm eligible to the SF in $t + 1$ relatively higher than the probability to obtain a new loan ending up above the eligibility threshold, after 2014Q1 than before ? The answer to this test is positive : the probability to obtain a loan lower than €1.5 million is 0.5 ppts higher (that is roughly a 17% increase) after than before compared with the probability to obtain a new loan higher than €1.5 million. Note that the number of observations is much more important, in relation with the different sample used for identifying potential relations (see previous section).

In column (7) and (8), we observe a more surprising result: it appears that the probability to terminate a relation (moving from a positive exposure to a null exposure the period latter) is comparatively higher (+0.8 ppts or +16%) for eligible firms than for ineligible ones after the introduction of the SF. At this stage, we cannot rationalize this rather counterintuitive result.

To our knowledge, the only paper that tries to assess the impact of the supporting factor on the provision of credit is the paper by Mayordomo and Rodrigues Moreno (2016). Our empirical analysis complements and extends their results along several dimensions. First, they explore the intensive margin while our analysis is oriented toward the extensive margin. We think it is crucial because one of the possible effects of the supporting factor is not only to increase the amount of credit provided to firms that already have access to credit but also to increase the pool of lenders: by making the capital requirements lower, the regulators were expecting to see an increase in the *access* to credit. Our results support this view. Second, they focus on the exposures within the [€1 million; €2 million] and their sample is centered on the medium-sized enterprises. In our analysis, we include the very small firms and we look at their improved access to credit. We will explore this heterogeneity of the effect of the SF along firm size in a future version which could validate the first part of our paper. Third, our identification benefits from a longer time series what is desirable in the case we think it could take time to banks to adjust. Finally and most importantly, to our knowledge, we are the first to identify a

possible adverse effect of the SF which could lead to ration relatively more firms that are marginally ineligible in order to make them eligible.

6. Conclusion

This paper looks at the effects of a unique policy reform that decreases banks' capital requirement in order to improve the access of the SMEs to banks credit. The paper contrasts with previous research that measures the effects of banks capital on credit distribution either by exploiting banks capital changes driven by external shocks -rather than policy decision- (Puri et al. 2011) or by exploiting a global rather than a local change in capital requirement targeting some counterparties (Behn et al., 2016).

The empirical strategy is based on a difference-in-difference approach run at the bank-firm level. It contrasts the exposures eligible to the capital relief with larger exposures. We explore the effect of the supporting on the access to credit, *i.e.* at the extensive margin. We find that indeed, the supporting factor seems to improve access to credit: the probability to get an extension of credit as well as the probability to obtain a new loan are both positively affected by the eligibility to the supporting factor. Moreover, we show that the supporting factor could have an unintended consequence in the form of rationing relatively more the marginally ineligible firms. We find results consistent with this view.

Policy makers show some concerns that such policy might increase banks risk taking. Exploiting a multifactor model consistent with the theoretical framework underlying the regulatory computation of capital requirement, we proceed to the computation of the "economic" capital where firm size is a risk factor. It allows for assessing at the portfolio level the relative risk of SME loans with respect to the larger firms loans. We compare the ratio of capital requirement and the ratio of economic capital by firm size. Taking into account the model uncertainty, we observe that the discount in capital requirement for SMEs offered by the SF is consistent with the discount in economic capital.

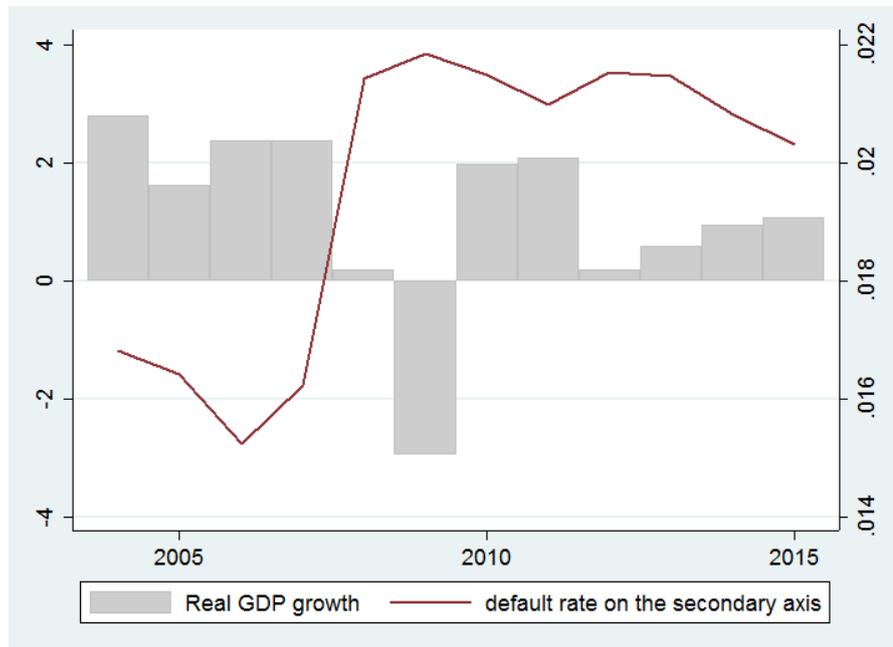
Our paper calls for the use of a supporting factor for promoting the access of SMEs to credit. However, the efficiency of such policy reform with respect to other type of reforms –for example targeted monetary policy- is let to further investigation.

7. References

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8. Figures

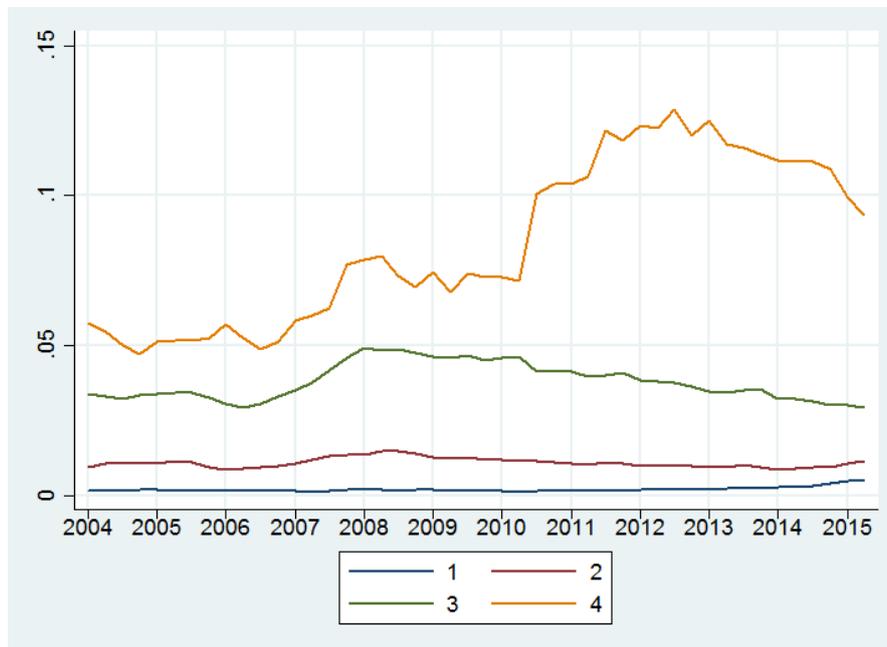
Figure 1: Default Rates over time (all size and rating classes) and change in real GDP



Note : these figure displays semi-annual changes in real GDP (left-hand axis) and the total default rate (right-hand axis) expressed as a percentage for the years 2004 to 2015 for France. The default rate is defined as the fraction of firms either filing for bankruptcy or defaulting on trade credit. The sample is made of firms operating in France with a yearly turnover larger than 750 k€ and a credit exposure larger than 25 k€. The sample of banks or foreign bank subsidiaries operating in France is exhaustive.

Source : Banque de France, Authors' calculation.

Figure 2: Default Rates (in %) over time (all size classes, by rating)



Note: these figures display the default rates for the years 2004 to 2015. The panel depicts the default rates for rating categories 1 (the safest category) to 4 (the riskiest category) for France. Rating categories for French exposures are defined thanks to the official rating given by the Banque de France department of businesses. These ratings are used as eligibility criteria to the refinancing operation of the Eurosystem. The default rate is defined as the fraction of firms either filing for bankruptcy or defaulting on trade credit. The French sample is made of firms operating in France with a yearly turnover larger than 750 k€ and a credit exposure larger than 25 k€. The sample of French banks or foreign bank subsidiaries operating in France is exhaustive.

Source : Banque de France.

9. Tables

Table 1: Random effects variances and correlations

Random effects variances (%)					
size classes	Retail	Corporate			
	0.75 – 1.5	1.5 – 5	5 - 15	15 - 50	> 50
Estimates	0.0094	0.0034	0.0163	0.0723	0.225
Standard Errors	0.01005	0.0012	0.0144	0.03602	0.07615

Correlation matrix of random effects					
size classes	0.75 - 1.5	1.5 – 7.5	7.5 - 15	15 - 50	> 50
0.75 - 1.5	1.0000				
1.5 – 7.5	0.6454	1.0000			
7.5 - 15	-0.5802	0.2520	1.0000		
15 - 50	-0.7361	0.04326	0.9721	1.0000	1.0000
> 50	-0.7698	-0.04406	0.9519	1.0000	1.0000

Table 1 shows the estimated variances of the random effects and their correlation matrix. All parameters in table 1 are significantly different from 0 with p-values lower than 1%.

Source : Banque de France and authors' calculation.

Table 2: Annual economic and regulatory capital ratios by size tranches (%)

Size (Turnover in million euros)	Multifactor model (1)	Regulatory Basel II/III model (2)	Regulatory CRD IV/CRR model with SF (3)	Ratio (2)/(1)	Ratio (3)/(1)
0.75 - 1.5	0.83	6.2	5.2	7.5	6.3
1.5 – 7.5	1.1	9.8	7.5	8.9	6.8
7.5 - 15	1.7	9.8	6.7	5.8	3.9
15 - 50	3.2	9.4	5.4	2.9	1.7
> 50	6.3	10.2	10.2	1.6	1.6

Table 2 shows the value of capital ratios when using the multifactor model (economic capital) and the regulatory Basel III model or the regulatory CRD/CRR model with supporting factor (SF). For the regulatory models, we used the IRB other retail formula for the computation of asset correlation in the smallest size class (0.75 to 1.5), and the IRB corporate formulas (with the corresponding size – turnover – adjustment) for the four last classes of medium and large enterprises.

Source : Banque de France – ACPR, French national credit register and authors' calculations.

Table 3 : Descriptive Statistics : eligibility status

Period	2010 - 2013		2014 - 2016	
	#	%	#	%
<i>Firm-level</i>				
Eligible	95,480	97.5%	91,667	97.6%
non-Eligible	2,467	2.5%	2,288	2.4%
Total	97,947	100.0%	93,955	100.0%
<i>Exposure-level</i>				
Eligible	1,336,858	98.1%	953,739	98.0%
non-Eligible	26,521	2.0%	19,323	2.0%
Total	1,363,379	100.0%	973,062	100.0%

Table 3 reports descriptive statistics for the database providing from the French credit national register for the periods 2010-2013, before the implementation of the Supporting Factor, and 2014-2016, after the reform. The top table shows the frequency and the share of SMEs eligible to the Supporting Factor while the bottom table displays the frequency and the share of exposures eligible. Eligible firms must display (i) an annual turnover lower than € 50 million and (ii) a total amount of relevant exposures within a banking group lower than € 1.5 million.

Source : Banque de France – ACPR, French national credit register and authors' calculations.

Table 4 : Descriptive Statistics

Variable	N	Mean	Std Dev.	P10	P25	Median	P75	P90
<i>Probability of...</i>		<i>Panel A : 2010-2013</i>						
<i>...loan extension</i>	1,363,379	0.11	0.32	0.00	0.00	0.00	0.00	0.00
<i>...loan reduction</i>	1,363,379	0.66	0.47	0.00	0.00	0.00	1.00	1.00
<i>...new loan</i>	3,725,100	0.04	0.19	0.00	0.00	0.00	0.00	0.00
<i>...terminating a loan</i>	1,363,379	0.05	0.21	0.00	0.00	0.00	0.00	0.00
<i>Probability of...</i>		<i>Panel B : 2014-2016</i>						
<i>...loan extension</i>	973,062	0.10	0.30	0.00	0.00	0.00	0.00	0.00
<i>...loan reduction</i>	973,062	0.68	0.47	0.00	0.00	0.00	1.00	1.00
<i>...new loan</i>	2,048,805	0.02	0.14	0.00	0.00	0.00	0.00	0.00
<i>...terminating a loan</i>	973,062	0.04	0.20	0.00	0.00	0.00	0.00	0.00
<i>Probability of...</i>		<i>Panel C : Full Period</i>						
<i>...loan extension</i>	2,336,441	0.11	0.31	0.00	0.00	0.00	0.00	0.00
<i>...loan reduction</i>	2,336,441	0.67	0.47	0.00	0.00	0.00	1.00	1.00
<i>...new loan</i>	5,773,905	0.03	0.18	0.00	0.00	0.00	0.00	0.00
<i>...terminating a loan</i>	2,336,441	0.05	0.21	0.00	0.00	0.00	0.00	0.00

Table 4 reports descriptive statistics. The database is made of 5% of the firms randomly sampled from the French credit national register. Panel A and Panel B respectively stands for the periods before and after the implementation of the Supporting Factor, while Panel C considers the whole period of experimentation. The probability of loan extension is a dummy equaling one if the outstanding amount of an existing exposure increases, the probability of loan reduction is a dummy equaling one if the outstanding amount of an existing exposure decreases, the probability of new loan is a dummy equaling one if the outstanding amount becomes positive while being null the quarter before and the probability of terminating a loan is a dummy equaling one if the outstanding amount is positive and become null the quarter after.

Source : Banque de France – ACPR, French national credit register and authors' calculations.

Table 5 : The impact of the SF on the distribution of credit at the extensive margin

	Probability of loan extension		Probability of loan amortization		Probability of new loan		Probability of terminated loan	
Eligible*Post	0.012*** (0.004)	0.013*** (0.004)	-0.020*** (0.006)	-0.019*** (0.006)	0.005*** (0.001)	0.004*** (0.001)	0.008*** (0.002)	0.008*** (0.002)
Observations	2,333,453	2,332,835	2,333,453	2,332,835	5,773,905	5,773,099	2,333,453	2,332,835
Adjusted R-squared	0.124	0.127	0.311	0.314	0.149	0.177	0.065	0.084
Year FE	YES	-	YES	-	YES	-	YES	-
Bank FE	YES	-	YES	-	YES	-	YES	-
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Rating FE	YES	YES	YES	YES	YES	YES	YES	YES
Size FE	YES	YES	YES	YES	YES	YES	YES	YES
Bank*Year FE	NO	YES	NO	YES	NO	YES	NO	YES

Table 5 reports estimates from a Linear Probability Model. Regressions include year, bank, firm, rating and size FE. An alternative specification includes bank-year FE. The variable Eligible*Post is the product of a dummy for being eligible and a dummy for being in the post SF introduction period. Regressions are clustered at the firm level. Clustered standard errors are in brackets. *** p<0.01, ** p<0.05, * p<0.1

Source : Banque de France – ACPR, French national credit register and authors' calculations.