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Compositional effects of O-SII capital buffers and the role of monetary policy

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Abstract

We investigate the impact of macroprudential capital requirements on bank lending behaviour across economic sectors, focusing on their potentially heterogenous effects and transmission channel. By employing confidential loan-level data for the euro area over 2015-18, we find that the reaction of banks to structural capital surcharges depends on the level of the required capital buffer and the economic sector of the borrowing counterpart. Although tighter buffer requirements correspond to stronger lending contractions, targeted banks curtail their lending towards credit institutions the most, while leaving loan supply to non-financial corporations almost unchanged. We find that this lending is mitigated when banks resort to central bank funding. These results have important policy implications as they provide evidence on the impact of macroprudential policy frameworks and their interaction with unconventional monetary policies.

JEL: E51, E58, E60, G21, G28

Keywords: Macroprudential Policy, Unconventional Monetary Policy, Credit Supply, Loan-level Data, Large Exposure

NON-TECHNICAL SUMMARY

In the aftermath of the global financial crisis (GFC), policymakers attempted to reduce the excessive risk-taking of large and complex financial institutions. One of the instruments introduced for such purpose was the additional capital buffer on other systemically important institutions (O-SIIs) which was envisaged to limit the negative externalities of a bank upon failure. While requirements for structural risks were imposed in many jurisdictions, their expected cost on bank lending and economic activity was unclear.

In this paper, we employ granular information on euro area bank large exposures to individual counterparts and run loan-level estimations over 2015-18. We find that O-SIIs reaction to the introduction of structural buffers depends on the level of the required capital surcharge as well as the borrower sector. Whilst tighter buffer requirements correspond to stronger lending contractions, banks curtail lending towards credit institutions the most, leaving loan supply to non-financial corporations almost unchanged. We also document the existence of an interaction between macroprudential and monetary policy regimes by showing that banks that exploit the ECB extraordinary liquidity interventions (TLTROs) curtail lending to credit institutions but not to non-financial corporations. By contrast, banks that did not take TLTROs contract lending to non-financial corporations but not to credit institutions.

These results suggest that unconventional monetary policies (UMPs) may have contained the negative spill-overs of the O-SII framework on the real economy. In particular, while the O-SII framework may incentivise banks to shrink loan portfolios in order to meet the required buffer level, the conditionality of the targeted operations contributed to steer the impact away from the non-financial sector, as price and access to the tool depends on lending to these firms. Our results are based on firms borrowing from multiple banks where banks differ in the level of the assigned capital buffer (as in Khwaja and Mian, 2008). They are robust to a wide range of econometric specifications and stand-up well to a broad range of robustness checks and sub-sample analyses.

1. Introduction

In the aftermath of the global financial crisis, policymakers attempted to reduce the excessive risk-taking behaviour of large and complex financial institutions. Since the costs associated to the failure of these entities had been very high and spilled-over to the whole financial sector (Bernanke, 2018), structural buffers on systemically important institutions were introduced as part of the macroprudential policy toolkit to improve the resilience of the financial sector and the stability of the financial system (Borio, 2015).[1] However, while additional capital requirements for structural risks were imposed in many jurisdictions, their expected impact on bank lending and economic activity was unclear.

The effect of capital requirements on bank lending remains debated in the literature. According to the "Modigliani-Miller" view, when banks are well capitalised, the cost of equity is modest (Hanson et al. 2011; Admati et al. 2013) and higher capital requirements improve bank ability to accommodate capital losses and lend to the real economy (Berrospide and Edge, 2010; Buch and Prieto, 2014). By contrast, Meyers and Majluf (1984), among others[2], claim that additional capital requirements constrain bank lending as regulatory requirements depend on the amount of loans granted (Thakor, 1996; Gambacorta and Mistrulli, 2004; Bolton and Freixas, 2006).

In practise, the link between capital requirements and bank lending behaviour has profound implications for policymakers in terms of financial stability and monetary policy transmission. Banks can, in principle, increase their capital requirements either by raising the level of regulatory capital (i.e. the numerator of the capital ratio) or by reducing their risk-weighted assets (i.e. the denominator of the capital ratio) (Gropp et al. 2019). However, when banks suffer from profitability pressures, they experience difficulties in issuing new equity or generating capital organically via retained earnings (ECB, 2018; Gambacorta and Shin, 2018). In such a scenario, the introduction of additional capital surcharges may improve financial

[1] Structural buffers are the capital buffers for Global Systemically Important Institutions (G-SIIs), the capital buffers for O-SIIs and the Systemic Risk Buffer (SRB) (ESRB, 2017).
[2] See also Cornett and Tehranian, 1994; Stein 1998.

stability but also lead banks to shrink their assets.[3] In this case, capital based macroprudential and monetary policies might interact and mutually influence each other.

Our results suggest that this is partially the case. We employ granular information on euro area bank large exposures to individual counterparts taken from supervisory reporting and run loan-level estimations over the 2015-18 period. We find that O-SII banks' reaction to the introduction of structural buffers depends on the level of the required capital surcharge as well as the borrower sector. Whilst tighter buffer requirements correspond to stronger lending contractions, banks curtail lending towards credit institutions the most, leaving loan supply to non-financial corporations almost unchanged.

We show that this heterogenous impact of higher capital requirements across economic sectors reflects the contemporaneous implementation of unconventional monetary policies (UMPs). In particular, we document the beneficial interaction of macroprudential and monetary policy regimes by showing that banks that exploit the ECB extraordinary liquidity interventions (TLTROs) curtail lending to credit institutions but not to non-financial corporations and vice-versa. These results suggest that UMPs contribute in containing the possible costs of the O-SII framework on the real economy.

The implementation of the O-SII capital framework, jointly with our analytical set-up, represents an almost ideal setting for a comprehensive assessment of the impact of capital requirements on bank lending for several reasons. First, institutions identified as O-SIIs are required to maintain different levels of capital buffers (spanning from 0% to 2%) depending on their score of systemic importance and on the outcome of the assessment performed first by national authorities and then by the ECB. This allows us to capture potentially non-linear effects that different levels of capital surcharges may have on bank lending, as well as strengthening our econometric identification. Second, by using loan-level supervisory data, we are able to assess the relevant transmissions channel of bank-specific macroprudential policies and their interaction with UMPs. Counterparty by counterparty information allows us also to control for confounding factors that may affect bank lending such as borrower-level credit demand and bank-level credit supply shocks. As in Khwaja and Mian (2008), our methodology for estimating the impact of O-SII buffers focuses on firms borrowing from

[3] Higher capital requirements might interact with the transmission of the monetary policies.

multiple banks, where banks differ in the level of the assigned capital buffer. In addition, we saturate our model with borrower and borrower-time fixed effects to capture both unobserved and observed time-varying heterogeneity in borrower fundamentals, thereby exhaustively controlling credit demand. Third, the granularity of the dataset employed allows us to disentangle the effect of capital buffers across economic sectors, specifically credit institutions and non-financial corporations.

To the best of our knowledge, our paper is the first to evaluate the impact of O-SII buffers on bank lending by considering buffer intensities and by employing loan-level data for euro area banks. We are also the first to investigate the heterogeneity of capital requirements on bank lending depending upon economic sectors in a cross-country setting. Our findings have also important policy implications for the implementation of macroprudential frameworks and their interaction with monetary policy regimes. If O-SII buffers lead to reduced lending to non-financial corporations, a decline in investment, consumption and real estate purchases may follow, negatively affecting the real economy. Likewise, if banks cut lending to credit institutions, liquidity "dry ups" across financial institutions with negative consequences for the stability of the banking sector may occur. UMPs such as the TLTROs appear to have a bearing on the impact of capital surcharges, thus containing the possible negative side-effects of the O-SII framework.

We differ from the established empirical literature in several ways.[4] First, we differ from earlier studies that focus on regulatory or macroeconomic shocks such as the concomitant the introduction of Basel I capital regulations and the 1990-91 U.S. recession (Bernanke and Lown, 1991; Hancock and Wilcox, 1993; Hall, 1993; Berger and Udell, 1994; Peek and Rosengren, 1995; Brinkmann and Horvitz, 1995) or on the effect of capital requirements on lending following the GFC (Albertazzi and Marchetti, 2010; Berrospide and Edge, 2010; Carlson et al., 2013; Rise and Rose, 2016). While these studies employ a single-country setting to investigate the effect of capital requirements (specifically the U.S. and Italy), our study adds to this stream of literature by exploiting a multi-country setting; i.e. capturing greater heterogeneity across banks and countries.

[4] For the theoretical literature we refer to Bolton and Freixas (2006), VanHoose (2007), Van de Heuvel (2008), and Gorton and Winton (2017), among others.

Second, we differ from studies that investigate whether binding capital requirements limit monetary policy manoeuvres aimed to boost bank lending (Thakor, 1996; Gambacorta and Mistrulli, 2004; Angelini et al. 2014). Similarly to Aiyar et al. (2016), we find an independent effect of capital requirements and monetary policy on bank lending. However, while they do not find any interaction between monetary policy and capital requirements, we add to this literature by showing that macroprudential and monetary policy can act as complements improving the resilience of the banking sector while contributing to the efficient allocation of resources in the real economy. Moreover, while Aiyar et al. (2016) focus on the level of interest rate, we employ bank-level TLTRO take-up data – a monetary policy tool that is specifically designed to boost bank lending to the real economy. We show that the interaction of the macroprudential requirement with an UMP with clear conditionality is crucial to limit adverse effects coming from the introduction of additional capital surcharges.

We also differ from earlier studies in terms of methodology and data employed. Hancock and Wilcox (1993); Hancock et al. (1995), Lown and Morgan (2006) apply vector autoregressive (VAR) methodology. Several papers use natural experiments exploiting differences in regulation between national and multinational banks (Peek and Rosengren, 1997; Peek and Rosengren, 2000; Puri et al. 2011) or individual bank policy experiments (Ayar et al. 2014a; Ayar et al. 2014b; Rice and Rose 2016; Imbierowicz et al. 2018) to investigate the effect of capital requirements on lending. However, most of these studies apply aggregate or bank-level data; i.e. being prone to endogeneity problems due to the omission of firm-level variables. Addressing this issue requires perforce bank lending and firm borrowing to be considered jointly. This allows to control for firm-level characteristics as well as firm-specific risk and credit demand. Indeed, a perennial challenge when examining the effect of bank capital requirements on lending growth is to separate supply from demand. In this respect, we follow Albertazzi and Marchetti (2010), Auer and Ongena (2016), Behn et al. (2016), Jimenez et al. (2017), Berrospide and Edge (2019), Degryse et al. (2019), Gropp et al. (2019), De Jonghe et al. (2020) and Fraisse et al. (2020) and control for demand effects by using highly detailed data on bank-firm relationship. However, while some of these authors focus on procyclical capital regulation on bank lending using a single country setting (Behn et al. 2016; Fraisse et al. 2019; De Jonghe, 2020) or stress test-related experiments (Berrospide and Edge, 2019; Calem et al. 2019; Gropp et al. 2019), we add to this literature by evaluating the impact

of O-SII buffers on bank lending by considering buffer intensities across European countries which depend on bank score of systemic importance.

Studies on the impact of structural buffers such as the O-SII are still limited. Cappelletti et al. (2019), in studying the impact of higher bank capital buffers of O-SII banks on lending in the euro area over the 2014-17 period, find that O-SII banks reduce lending to household and financial sectors in the short-term, whilst in the medium-term the effect is appeased. However, since they use bank-level data, they are not fully able to disentangle credit supply from credit demand shocks. Andries et al. (2019) investigate CDS spreads reaction to the EBA disclosure of O-SII banks. While they find that CDS spreads increase when the EBA published the O-SII list, they do not specifically investigate bank lending behaviour. Our work enriches and expands this strand of the literature as well.

Finally, we add to the aforementioned literature by investigating the compositional effect of capital requirements which, so far, has received limited attention. In this respect, our paper is closer to Auer and Ongena (2016) who examine the effects of the countercyclical capital buffer (CCyB) introduced in 2012 on Switzerland bank residential mortgage portfolios. They find that the CCyB, which was intended to curb mortgage lending, affects lending to corporates instead. However, we differ from this study by exploring the heterogeneity of capital requirements on bank lending depending upon economic sectors and show that differences exist with respect to the impact on financial and non-financial corporations.

The rest of the paper is organised as follow. Section 2 recalls the O-SII framework and Section 3 presents our empirical methodology. Section 4 introduces our data as well as the Large Exposure reporting regime while the results are discussed in Section 5. Robustness checks are included in Section 6 and Section 7 concludes.

2. Institutional background: The O-SII framework and O-SII sample

Since the savings and loan (S&L) crisis, but especially after the GFC, banking regulators recognised that large and complex financial institutions may disproportionately contribute to systemic risk owing to their size, business model, market role, interconnections with other firms and linkages to the real economy. Regulators introduced reforms envisaged to address the “too-big-to-fail” problem by increasing the loss absorbency capacity of systemically

important banks. While these buffers were firstly applied to global systemically important banks (G-SIBs), in October 2012 the Basel Committee for Banking Supervision (BCBS) published its global framework for dealing with domestic systemically important banks (D-SIB), outlining a set of principles on the assessment methodology and the higher loss absorbency (HLA) requirement for banks identified as D-SIBs. The European Union implemented this framework in the Capital Requirements Directive 2013/36/EU (CRD IV) defining the concept of Other Systemically Important Institutions (O-SIIs): financial institutions whose failure may pose negative externalities on the domestic financial system and the wider economy. According to the CRD IV, competent authorities in the EU Member States should designate O-SIIs within their jurisdiction in line with their systemic importance and may set capital buffers for the identified banks. Their designation and the level of buffers should be reviewed annually. The O-SII buffer requirement (capped at 2% of the total RWA under CRDIV) has to be met by Common Equity Tier 1 (CET1) capital in addition to minimum Pillar 1 and Pillar 2.[5]

For the identification of O-SIIs, most national competent authorities follow the methodology prescribed in the EBA guidelines, which establish a two-step process to assess the systemic importance of individual institutions.[6] The first step is based on a scoring process which includes 10 indicators corresponding to the categories of size, importance, complexity and interconnectedness (see Table 1). Institutions whose score exceeds 350 bps are automatically designated as O-SIIs.[7] In the second step, national competent authorities can designate further institutions via supervisory judgement.[8]

[5] The update of the Capital Requirements Directive (CRD V) finalised in May 2019 introduces some changes to the existing O-SII framework. Once the directive is transposed to national laws, national competent authorities will be able to require each O-SII to maintain an O-SII buffer of up to 3 % of RWAs.

[6] See the "Guidelines on the criteria to determine the conditions of application of Article 131(3)" of Directive 2013/36/EU (CRD) in relation to the assessment of other systemically important institutions(EBA/GL/2014/10, December 2014).

[7] The EBA guidelines leave some room for flexibility to reflect the specificities of individual member state banking systems, allowing national competent authorities to increase or reduce the identification threshold by up to 75 bps.

[8] While country discretion may lead to endogeneity issues as national authorities increase the identification threshold or apply supervisory judgement to banks with lower lending growth, the ECB introduced a floor to O-SII buffer calibration in 2016. This floor ensures that minimum requirements are set homogeneously within the euro area for banks with a similar score, thus limiting the potential bias. Nevertheless, we remove in our robustness tests (a) those countries that apply a higher identification threshold and (b) those where supervisory judgement has taken place and our results are unaffected.

[Insert Table 1 here]

EBA Guidelines are silent with respect to the calibration of O-SII buffer rates resulting in significant differences across countries with respect to the assigned buffers (Sigmund, 2019). In a similar fashion, the timing to implement the measure is also quite heterogeneous. Twelve euro area countries decided to implement a positive O-SII capital surcharge as of 1st January 2016, while the remaining deferred the implementation beyond this date. In addition, different phase-in periods have been adopted. Only eleven countries have already set aside their fully loaded buffers and those remaining will complete the implementation by 1st January 2022 (Table 2).[9]

Descriptive statistics for O-SII buffers are displayed in Table 2. Specifically, 101 banks are identified as O-SIIs in our sample, whilst 913 as non O-SIIs, over the 2015-18 period. As aforementioned, the EBA guidelines do not provide any guidance on how the O-SII buffer should be calibrated. EU countries have employed various methods and, sometimes, additional indicators for the calibration of O-SII buffers. This reflects the high degree of heterogeneity of the different buffer levels across countries (Table 2). Specifically, 36 banks have buffer between 0.25% and 0.50%, 34 between 0.50% and 1%, 12 between 1% and 1.50% and 19 between 1.50% and 2%.[10]

[Insert Table 2 here]

3. Methodology

To investigate whether O-SII capital surcharges induced significant changes in the supply of credit to borrowers exposed to banks with different buffer intensity, we follow the methodology employed by Khwaja and Mian (2008). By exploiting the presence of multibank relationships, we control for loan demand and include observed and unobserved firm characteristics. This helps to isolate credit supply changes (e.g. due to changes in regulatory

[9] With some exceptions, the O-SII buffer is currently offset against buffers for Global Systemically Important Institutions (or G-SIIs, the term used in the EU legislation to refer to G-SIBs) and against systemic risk buffers (SyRB), i.e. only the highest of these three instruments is binding.

[10] The greater number of non O-SII banks compared to O-SII does not harm the analysis as O-SII banks hold greater amount of large exposure loans overall. Hence, the need to use a larger number of non O-SII banks to match O-SII large exposure. In a robustness check (not reported in the paper), we also control for the validity of our finding by using the propensity score matching which, by pairing each bank with a control unit, allows us to control for banks having similar characteristics.

capital charges) from shifts in loan demand. Our econometric specification takes the following form:

$$\Delta Y_{ijt} = \alpha_i + \tau_{jt} + \beta_1 Db1_{it} + \beta_2 Db2_{it} + \beta_3 Db3_{it} + \beta_4 Db4_{it} + \beta_5 X_{it} + \beta_6 Z_{bt} + \beta_7 K_{it} + \varepsilon_{ijt} \quad [1]$$

where reporting banks are denoted by *i*, borrowing firms by *j*, country of a reporting bank by *b* and time by *t*. ΔY defines our dependent variables (ΔL, ΔL_CI, ΔL_NFC). Specifically, ΔL is the annual logarithmic change of total loans of bank *i* to borrower *j* at time *t,* i.e. the change in lending observed the year following the introduction of an O-SII buffer. ΔL_CI is the annual logarithmic change of loans to credit institutions of bank *i* to bank *j* at time *t*. ΔL_NFC is the annual logarithmic change of loans to non-financial corporations of bank *i* to firm *j* at time *t*. Db1 to Db4 are binary variables indicating buffer ranges of 50 basis points for O-SII banks, where the benchmark dummy is determined by non-OSII banks (Table 3).[11] For example, Db1 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0% and 0.50% (included), and 0 otherwise. This specification allows us to test for non-linear effect of additional capital surcharges.

[Insert Table 3 here]

X is a vector of bank-specific characteristics that includes the logarithm of bank total assets (Size), the ratio of equity to total assets (E/TA), the non-performing loans ratio (NPLs), the ratio of deposits to total liabilities (Funding structure) and the net interest margin (NIM). Z is a vector of country-specific characteristics we use to control for the macroeconomic environment between European countries and includes inflation (Inflation) and the growth of nominal GDP (GDP). Since O-SII buffers phase-in periods vary among countries, we include, as additional control variable (vector K), the number of years between the announcement date and the fully loaded date for each O-SII.

To tighten identification, we also include bank fixed effects (α) to control for unobservable bank-specific factors. We also use borrower-time fixed effects (τ) to control for observed and unobserved borrower heterogeneity that may vary overtime, thus isolating credit supply from

[11] The capital levels applied are not the transitional values but the fully phased in values agreed by national macroprudential authorities and the ECB.

credit demand shocks. ε is the idiosyncratic error term. In the banking literature, borrower-time fixed effects are commonly employed to deal with firm-level demand shocks (see for instance, Jimenez et al. 2014 and Jimenez et al. 2017). A limitation of this approach is underlined by Paravisini et al. 2014 which argue that firm-level fixed effects may fail to control for all demand effects if borrowing from a given firm is not randomly assigned or firms borrow from the same banks. We mitigate this identification issue by considering multi-bank relationship, i.e. firms that borrow from more than one bank. Indeed, bank and borrower-time fixed effects in the specification in equation [1] absorb the effects on lending of firms that borrow from only one bank throughout the sample, i.e. implicitly focusing on firms borrowing from multiple banks. Our econometric specification compares how the same firm loan growth from one bank changes relatively to another bank that has: (a) different buffer level or; (b) is not an O-SII. The within borrower comparison absorbs borrower-specific changes in credit demand. This allows us to attribute estimated differences in loan growth to capital buffer requirements. Robust standard errors are double-clustered at the bank and borrower level (Behn et al., 2016, Jimenez et al., 2017). This means that we allow standard errors to be correlated within bank-borrower cluster but not across them.

We also consider an alternative econometric specification where we replace borrower-time fixed effects, country and bank controls with borrower control variables (credit institutions and non-financial corporations) and borrower country-time fixed effects that we denote as T, Y, and ψ, respectively. Specifically, T is a vector that includes the same bank-specific control variables as in equation [1] to financial institutions that are borrowers in the specification. Y is a vector that includes borrower-specific characteristics such as the operating revenues to total asset ratio, the solvency ratio and firm size (the logarithm of firm total assets) to control for observed borrower-specific characteristics that may affect bank lending decisions. This econometric specification takes the following form:

$$\Delta L_{ijt} = \alpha_i + \psi_{bt} + \beta_1 Db1_{it} + \beta_2 Db2_{it} + \beta_3 Db3_{it} + \beta_4 Db4_{it} + \beta_5 T_{it} + \beta_6 Y_{jt} + \beta_7 K_{it} + \varepsilon_{ijt} \quad [2]$$

As in Jimenez et al. 2017, equation [2] restricts the sample to loans that can be matched to borrower-specific characteristics. This allows to test for differences between the two specifications.

4. Data

To investigate the impact of O-SII capital surcharges on bank lending behaviour, we construct a granular dataset combining supervisory confidential and public information. Euro area bank capital requirement – including detailed information on required capital buffer, date of notification, publication and implementation of the policy – are taken from ECB confidential supervisory data and national authorities annual notifications to the European Systemic Risk Board (ESRB). Granular information on euro area bank large exposures data to individual counterparties is taken from supervisory reporting (COREP 27-31) which requires SSM banks to report detailed information about their large exposures since 2014.[12] Balance sheet information on reporting institutions is drawn from the ECB supervisory statistics, whilst balance sheet data of non-financial corporations are sourced from Amadeus. Macroeconomic variables are drawn from the ECB Statistical Warehouse Database. As shown in Table 2, our sample covers 1,014 financial institutions from 19 Euro area counties over the period 2015-18.

4.1 Large Exposure Data

Our loan-level dataset includes large exposure loans which stem from the large exposure regime, introduced in the EU in 2014, to ensure that risks arising from large exposures are kept at bay by limiting the maximum loss a bank could incur in the event of a sudden counterparty failure. According to Article 393 of the Capital Requirements Regulation (CCR), an exposure to a single client or connected group of clients is considered a large exposure when, before the application of credit risk mitigation measures and exemptions, it is equal or higher than 10% of an institution eligible capital or has a value equal or higher than €300 million. Our dataset encompasses detailed information about exposures (e.g. instruments), reporting entities and counterparties (e.g. LEI, country and sector), which allows us to link the large exposure dataset to complementary data sources.[13] The large exposure templates are

[12] Common Reporting (COREP) is the standardized reporting framework issued the EBA for the CRD reporting. It covers credit risk, market risk, operational risk, own funds and capital adequacy ratios.

[13] Group structures are reconstructed using information about direct and ultimate parent reported in other templates of the supervisory data collection. Since capital requirements may be applied at different levels of consolidation, it is extremely important to disentangle contributions from individual entities inside a group. If the parent institution of a banking group reports both at individual and consolidated level a large exposure of €300 million, the exposure should appear in the dataset only once and it should be assigned to the parent. If a

reported at the highest level of consolidation and, for the most relevant group sub-structures, also at individual level. Detailed information about banking groups available at the ECB allows us to refine the dataset, allocating exposure to specific group components and eliminating duplicates. In line with the majority of the literature investigating the effect of capital requirements on bank lending behaviour using loan level data (Behn et al., 2016; Gropp et al., 2019; Berrospide and Edge, 2019), we use the logarithmic growth rate of lending. Panel A of Table 3, displays summary statistics of our dependent variables.

Since our large exposure data are mostly concentrated in few countries (Table 2), our sample could suffer from a selection bias. For instance, Germany, France and Italy cover more than 75% of the overall large exposure data in the dataset. To test whether the results hold also for the other countries in the sample we remove, in a robustness check in Section 7, Germany, France and Italy from the analysis.

4.2 Bank and firm balance sheet and macroeconomic data

Panel B of Table 3 shows summary statistics of bank balance sheet data. We employ the ratio of equity on total assets (E/TA) as a measure of bank capitalisation. A large literature (Bernanke and Lown, 1991; Hancock and Wilcox 1994; Gambacorta and Mistrulli, 2004; Berrospide and Edge, 2010) has shown that weakly capitalised banks may try to improve their capital requirement metrics by cutting credit exposure. Hence, if the banking sector is not well-capitalised, tighter capital buffers may influence the transmission of monetary policy to credit supply to the real economy. We use the non-performing loans ratio (NPLs) to control for the effect of asset quality in bank loans portfolio (Altunbas et al. 2012). Banks with better asset quality should be able to insulate the supply of credit from regulatory shocks, such as the introduction of O-SII buffers. We also use deposits over total liabilities (Funding structure) to control for the effect of bank funding structure on bank lending (Bustamante et al. 2019). We use the logarithm of total assets (Size) as large banks may find easier to raise alternative sources of funds to support lending. We proxy bank business models by using net interest margin (NIM), which is defined as the difference between interest earning assets and

subsidiary of a banking group reports a large exposure above 10% of its capital but below 10% of the group's capital, the exposure should appear in the dataset (to make it as complete as possible) and it should be assigned to the subsidiary.

interest bearing liabilities divided by the amount of interest earning assets. Higher NIM should indicate higher reliance on interest income activity and consequently lending.

[Insert Table 4 here]

Panels C of Table 4 displays descriptive statistics for firm-level and policy variables. As Jimenez et al. (2017), we employ size, solvency and profitability to control for firm-specific characteristics. Arguably, larger, less leveraged and more profitable firms should demand more loans than firms with weaker balance sheets. Finally, as in Gambacorta and Shin (2018), we employ the annual growth rate of nominal GDP and inflation to control for business cycle differences among European countries in the sample (Table 3).

5. Results

5.1 Baseline Results

This section discusses the empirical results for the loan-level panel regression analysis based on equation [1] and [2]. Columns 1 – 6 of Table 5 present the results with the inclusion of several combinations of fixed effects and control variables. The first column of Table 1 shows that O-SII banks reduce lending in comparison to non O-SII banks. The magnitude of the coefficient increases as the buffer gets tighter. Specifically, banks with lower buffer requirements, i.e. below 1.0% and captured by Db1 and Db2, curtail lending by about 0.86 pp and 1.96 pp (Column 1), respectively. As the buffers tighten, banks' lending contraction increases: a capital buffer ranging between 1.0% and 2.0%, captured by Db3 and Db4, would reduce credit by 2.65 pp and 3.32 pp (Column 1) compared to non-OSII banks, respectively. This specification includes bank- and borrower-fixed effects, which absorb unobservable bank- and borrower-specific characteristics. In the second Column of Table 5, we tighten our econometric identification by including borrower-time fixed effects to control for observed and unobserved borrower heterogeneity that may vary overtime, thus isolating credit supply from credit demand shocks. As shown, the results continue to hold for all the buffer levels which allows us to suggest that the lending contraction can be attributed to a reduction in credit supply and that is not driven by demand effects.

In Columns 3 and 4, we include bank- and country-specific control variables, hence including time varying observable factors that may affect the supply of credit. Although slightly less

significant, the magnitude of the dummy coefficients is in-line with the other econometric specifications. Moreover, Db1, capturing buffers below 0.5%, loses its significance level indicating that an O-SII buffer in the order of 0.25% to 0.50% has minor impact on bank lending. Finally, in Columns 5 and 6, we replace borrower-time fixed effects with borrower specific-characteristics and country-time fixed effects. This softer econometric specification allows us to check whether borrower-time fixed effects (in Columns 2 – 4) are effective in controlling for credit demand shocks. The coefficient in Columns 5 and 6, which is more than 2pp higher than the other specifications, highlights the importance of fully isolating credit demand shocks for an accurate estimation of bank lending behaviour. The introduction of borrower characteristics in specification in Column 6 – which includes fewer observations – does not change the significance level of our estimates and further validates our findings. Overall, we find that O-SII buffer requirements reduce lending and that this effect depends on the level of the required capital buffer with tighter buffer requirements corresponding to stronger lending contractions.

[Insert Table 5 here]

5.2 Impact across sectors and the role of unconventional monetary policy (TLTROs)

We investigate the possible heterogeneity in lending contraction across sectors in Table 6 and 7 where lending to credit institutions (Table 6, Columns 1 – 6) and to non-financial corporations (Table 7, Columns 1 – 6) are separately investigated via sub-samples. Again, the results are presented with the inclusion of several combinations of fixed effects and control variables. The results of Tables 6 and 7 indicate that O-SII banks reduce lending to credit institutions but not to non-financial corporations compared to non O-SII banks and the coefficients marking the contraction in loans to credit institutions are similar in magnitude to those obtained in the baseline regression. As in Table 5, the coefficients increase in magnitude as the capital surcharges tighten. Specifically, banks reduce lending to credit institutions by 1.12 pp (Db1) to 4.92 pp (Db4). These coefficients are robust to different econometric specifications and the inclusion of macroeconomic as well as borrower-specific characteristics. Contrarily, Table 7 shows smaller coefficients and a statistically insignificant contraction of lending to non-financial corporations. Hence, we envisage that the implementation of the O-SII framework may have limited direct costs for the real economy.

In the years following the assignment of an O-SII buffer, identified banks appear to contract their lending provision to credit institutions but not to non-financial firms.

[Insert Table 6 here]

[Insert Table 7 here]

In recent years, the ECB adopted a wide range of unconventional monetary policies (UMPs) in order to cope with slow economic growth, weak inflation outlook and subdued credit dynamics in the euro area (BIS, 2019) which may have interacted with the O-SII regime.[14] The negative effects of a lending contraction to credit institutions or non-financial corporations due to increased capital requirements may thus have been avoided by the deployment of monetary tools.

To investigate whether UMPs have eased the negative effects of capital surcharges on bank lending we examine the lending behaviour of those banks that borrowed from the ECB's Targeted Longer-Term Refinancing Operations (TLTROs) compared to those that did not.[15] TLTROs are particularly suitable for this exercise as they were "*designed to enhance the functioning of the monetary policy transmission mechanism by supporting bank lending to the real economy*" (Draghi, 2014a). If banks taking the TLTROs cut lending to credit institutions but not to non-financial corporations, we can postulate that O-SII buffers ignited a withdrawal of loans from other credit institutions to reduce banks' own systemic footprint and O-SII score, in an effort to reduce the capital surcharge. At the same time, banks would opt to not cut lending to the non-financial sector as the price of TLTRO funding was linked to clear conditions with respect to lending to these firms.

In Tables 8 and 9 we further split our sample by considering TLTRO and non-TLTRO banks separately. Banks that borrowed from the ECB show a statistically significant lending

[14] UMP relates to policies that guide longer-term interest rate expectations and expand and change the composition of central bank's balance sheet with the aim to facilitate credit expansion (Bernanke and Reinhart, 2004).

[15] A first set of TLTROs was launched in June 2014 to support lending by reducing bank funding costs. The ECB's policy was implemented through eight auctions, between September 2014 and June 2016. A second set of interventions was announced in March 2016 and implemented between June 2016 and March 2017, and a third in March 2019 – beginning in September 2019. Differently from standard monetary policy measures, these loans have a significantly longer maturity. Technical details can be found at www.ecb.europa.eu/mopo/implement/omo/tltro/html/index.en.html.

contraction to credit institutions (Panel A and Table 8) but not to non-financial corporations (Panel B and Table 8) where the coefficients are statistically insignificant.[16] Again and as in the previous regressions, lending contraction increases with the buffer level. The magnitude of the coefficient is also economically meaningful as banks with tighter buffers reduce lending to credit institutions by about 12 pp (Column 1) compared to non O-SII banks. On the contrary, banks that did not receive extraordinary liquidity from the ECB curtail their lending to non-financial corporations (Panel B and Table 9; statistically significant at conventional level in most of the specifications) but not to credit institutions (Panel A and Table 9; statistically insignificant in all the specifications). These findings confirm our hypothesis that UMPs cushion the negative effects of capital buffers on the real economy. Thus, by pursuing their respective objectives, macroprudential and monetary policy appear to act as complements in improving the resilience of the banking sector while contributing to the efficient allocation of resources in the real economy (Praet, 2018).

[Insert Table 8 here]

[Insert Table 9 here]

6. Robustness checks

In order to provide more robustness to our findings, we conducted a series of additional tests. As a first robustness check, we control whether the large exposure regime set up drives our results. As mentioned in Section 5.1, an exposure to a single client or connected group of clients is considered a large exposure when it is equal or higher than 10% of an institution's eligible capital or has a value equal or higher than €300 million. Since banks need to meet additional capital surcharges by raising the amount of capital, it may be possible that an exposure greater that 10% of capital (thus flagged as large exposure) falls below this threshold when additional capital is raised. This – if not controlled for – may result in a lending contraction that is not driven by banks' reaction to the capital surcharges but rather by changes in the reporting framework of the large exposure regime. To rule out this possibility, we remove all observations that are identified as large exposure by considering the capital threshold and not on the absolute amount, i.e. dropping all the observations that are below

[16] For this exercise, we group banks with buffers between 1.0% and 2.0% (Db3 and Db4) to increase the number of data points in the estimation.

€300 million. The results reported in Panel A of Table 10 (Columns 1-3) further corroborate our baseline.

In a second robustness check, we test whether curtailed lending to credit institutions is directed mostly to non-OSII banks. If O-SII capital surcharges lead O-SII banks to reduce lending to non-OSII banks, non O-SII banks that are liquidity-dependent from O-SII banks may have contracted lending to non-financial corporations. Since our baseline dummy in the econometric identification is determined by non O-SII banks, the baseline results in Table 5 and the results on non-financial corporations in Table 7 may be the consequence of a stronger lending contraction to non-financial corporations that is driven by those non-OSII banks that experienced a liquidity dry up from affected O-SII institutions. We control for this possibility by: (a) removing all those non-OSII banks that borrow from O-SII banks. This leaves the dataset with O-SIIs that borrow from O-SIIs, non O-SII that borrow from non O-SIIs and O-SIIs that borrow from non O-SIIs. And (b) we exclude non O-SII banks that borrow from O-SIIs in the econometric specification of lending to non-financial corporations (ΔL_NFC). The results reported in Panel B of Table 10 (Column 3) are all insignificant and further validate our findings.

As a third robustness check, we remove all the G-SIIs and their subsidiaries from the sample. In the context of CRDIV, the O-SII buffers are currently offset against the G-SII and the systemic risk buffer (SyRB); i.e. only the highest of the three is binding. Since G-SIIs were subjected to a G-SIIs buffer before the implementation of the O-SII framework, the former may have already intervened to change bank lending behaviour. However, when G-SIIs are dropped from the sample, the resulting coefficients are in line with the baseline, with the only exception of Db3 in Column 2 (Panel C of Table 10, Columns 1-3).

As mentioned in footnotes 9 and 10, the EBA guidelines leave some room for flexibility to reflect specificities of individual member state banking system, allowing national competent authorities to increase or decrease the identification threshold by up to 75 bps. In addition, national authorities can designate further institutions via supervisory judgment. National discretion may lead to endogeneity biases in our estimates as policy makers may increase the identification threshold or apply supervisory judgement when their banking sector suffer from weak lending growth. To control for this issue, we remove, in a first robustness, countries that

apply a higher identification threshold (Latvia, Slovenia and Slovakia)[17] and, in a second robustness, those countries where supervisory judgement has taken place (Belgium, Germany, Estonia, France, Luxembourg, Malta and the Netherlands). Our results, displayed in Panel D and E of Table 10, Columns 1-3), discard this hypothesis and are consistent with the baseline estimates.

Finally, since our large exposure data are mostly concentrated in few countries (Table 2), our sample could suffer from a selection bias. For instance, Germany, France and Italy cover more than 75% of the overall large exposure data in the dataset. To test whether the results hold also for the other countries in the sample we remove Germany, France and Italy from the sample. Again, these results are not only in line but somehow stronger than our baseline regression (Panel D of Table 10, Columns 1-3).

[Insert Table 10 here]

7. Conclusion

In this paper we have investigated the impact of structural buffers, e.g. O-SII buffers, on aggregate lending as well as lending across different economic sectors, and explored their interaction with the TLTROs using loan level data for the euro area. This topic, which is still under-researched from an empirical perspective, is expected to become increasingly relevant given the deployment of macroprudential tools and continued difficulties for banks to raise capital.

We have shown that the lending reaction of other systemically important banks (O-SII) depends on the intensity of the required capital buffer, the economic sector of their borrowing counterpart and banks' recourse to central bank funding. We have offered evidence that, although tighter buffer requirements correspond to stronger lending contractions, designated O-SII banks curtail their lending towards credit institutions the most while leaving loans supply to non-financial corporations almost unchanged. This finding alone provides further insights into the transmission mechanisms of macroprudential policies.

Finally, we put forward an explanation that hinges on the interaction between macroprudential and monetary policy regimes such as TLTROs. As O-SII banks appear to de-

[17] Specifically, the threshold is set at 425, 500 and 425 for Latvia, Slovenia and Slovakia, respectively.

lever in order to shrink their balance sheets, the compositions of this lending contraction is affected by the conditionality of the targeted operations of the ECB. In fact, we showed that the effect of capital requirements on lending to non-financial corporations is eased only when banks resort to central bank funding, as banks that do not borrow from the ECB in its TLTROs cut lending to non-financial corporations while keeping that to credit institutions unchanged.

To the best of our knowledge, our paper is the first to evaluate the impact of O-SII buffers on bank lending by considering buffer intensities and by employing loan-level data and to investigate their heterogeneous impact on economic sectors. Our findings also have important policy implications for the implementation of macroprudential frameworks and their interaction with monetary policy. These results are robust to a wide range of checks.

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Tables

Table 1. O-SII scoring: indicators and criterion (EBA, 2014)

Criterion	Indicators
Size	Total assets
Importance (including substitutability/financial system infrastructure)	Value of domestic payment transaction Private sector deposits from depositors in the EU Private sector loans to recipients in the EU
Complexity/cross-border activity	Value of OTC derivatives (notional) Cross-jurisdictional liabilities Cross-jurisdictional claims
Interconnectedness	Intra-financial system liabilities Intra-financial system assets Debt securities outstanding

Table 2. Dummies and capital requirement intervals

Dummy label	Dummy value and capital requirement
Db1	1: O-SII buffer between 0% and 0.5% 0: otherwise
Db2	1: O-SII buffer between 0.5% and 1.0% 0: otherwise
Db3	1: O-SII buffer between 1.0% and 1.5% 0: otherwise
Db4	1: O-SII buffer between 1.5% and 2.0% 0: otherwise

Table 3. Summary statistics O-SII identification framework, large exposure and macroeconomic variables over 2015-18.

	Number of Banks											
	Overall	O-SII	Not O-SII	Buffer Level				Sup Judg.	Year fully phased	Large exposure (%)	GDP growth(%)	Inflation(%)
				db1	db2	db3	db4					
Austria	131	6	125	0	2	0	4		2019	1.89	3.82 (0.35)	1.64 (0.53)
Belgium	30	7	23	0	4	3	0	Y	2018	2.09	3.06 (0.33)	2.02 (0.07)
Cyprus	12	5	7	1	1	2	1		2022	0.19	5.15 (0.88)	0.07 (1.32)
Germany	174	12	162	4	6	1	1	Y	2019	31.79	3.49 (0.16)	1.23 (0.53)
Estonia	6	2	4	0	1	0	1	Y	2016	0.05	7.20 (1.70)	2.27 (1.53)
Spain	46	6	40	4	2	0	0		2019	7.63	3.70 (0.32)	1.13 (0.95)
Finland	62	3	59	2	0	0	1		2016	0.37	3.54 (0.55)	0.72 (0.29)
France	135	6	129	2	3	1	0	Y	2019	27.45	2.21 (0.61)	1.01 (0.67)
Greece	8	4	4	0	4	0	0		2022	1.32	1.36 (1.29)	0.29 (0.83)
Ireland	20	6	14	3	1	2	0		2019	1.8	6.50 (2.09)	0.27 (0.20)
Italy	110	4	106	2	2	0	0		2019	15.97	2.05 (0.25)	0.75 (0.59)
Lithuania	8	3	5	0	0	0	3		2017	0.1	6.20 (1.92)	2.37 (1.18)
Luxembourg	64	7	57	6	0	0	1	Y	2019	2.65	4.40 (1.31)	1.17 (0.63)
Latvia	16	5	11	0	0	2	3		2018	0.09	6.44 (2.56)	1.83 (1.21)
Malta	18	3	15	1	0	1	1	Y	2019	0.81	8.15 (0.90)	1.04 (0.30)
Netherlands	35	5	30	0	2	0	3	Y	2019	5.45	3.80 (0.32)	1.12 (0.58)
Portugal	112	5	107	4	1	0	0		2019	0.78	3.81 (0.32)	0.98 (0.30)
Slovenia	15	7	8	6	1	0	0		2019	0.14	5.57 (1.28)	1.02 (0.77)
Slovakia	12	5	7	1	4	0	0		2016	0.07	4.35 (1.43)	1.08 (1.24)
Total/Average	1014	101	913	36	34	12	19			100	3.29 (1.25)	1.14 (0.69)

Notes: Table 1 displays summary statistics of the O-SII identification framework and mean and standard deviation (in parentheses) of large exposure and macroeconomic data divided by country. Number of banks shows the overall number, the number divided by O-SII and not O-SII and by buffer levels. Large exposure is the cumulative distribution of large exposure loans by country in percentage. GDP growth is the annual logarithmic growth rate of nominal GDP in percentage. Inflation is the annual inflation rate in percentage.

Table 4. Descriptive Statistics

	Obs	Mean	St.dev	Min	Max
Panel A. Dependent Variable					
ΔL	34300	0.0003	0.1277	-0.2430	0.2313
ΔL_CI	15800	-0.0114	0.1488	-0.3182	0.2325
ΔL_NFC	8529	0.0030	0.1324	-0.3466	0.2781
Panel B. Bank Characteristics					
E/TA	38300	0.0754	0.0338	0.0258	0.1728
NPL ratio	31000	0.0436	0.0478	0.0004	0.2657
Funding structure	32200	0.7479	0.1866	0.2156	0.9897
Size	38300	24.6065	2.4844	15.4473	28.3327
NIM	38200	0.0072	0.0040	0.0005	0.0162
Panel C. Borrower characteristics					
Operating revenues	21700	0.0007	0.0106	-0.0001	0.4000
Solvency ratio	21900	0.2051	0.2316	-0.2933	1.0000
Firm size	22000	24.2351	3.0624	2.3026	28.3742
Panel D. Policy characteristics					
Length phase-in	26225	4.0211	0.6642	1.0000	7.0000

Notes: Table 4 shows summary descriptive statistics. (ΔL) is the annual logarithmic growth rate of total bank lending. ΔL_CI is the annual logarithmic change of loans to credit institutions. ΔL_NFC is the annual logarithmic change of loans to non-financial corporations. E/TA is the ratio of bank equity to total assets. NPL ratio is the ratio of non-performing loans to gross loans. Funding structure is the ratio of deposits to total liabilities. Size is the logarithm of bank total assets. NIM is the net interest margin computed as the difference between interest earning assets and interest bearing liabilities divided by the amount of interest earning assets. Operating revenues is the ratio of operating revenues to total assets. Solvency ratio is the sum of after tax net profits and depreciation divided by total liabilities. Firm size is the logarithm of firm total assets. Length phase-in is the number of years between the announcement data and the fully loaded period.

Table 5. Baseline Results

	(1) ΔL	(2) ΔL	(3) ΔL	(4) ΔL	(5) ΔL	(6) ΔL
Db1	-0.0086**	-0.0080*	-0.0054	-0.0051	-0.0138**	-0.0165***
	(0.0036)	(0.0044)	(0.0047)	(0.0047)	(0.0056)	(0.0060)
Db2	-0.0196***	-0.0191***	-0.0170**	-0.0164**	-0.0300***	-0.0315***
	(0.0055)	(0.0067)	(0.0069)	(0.0070)	(0.0089)	(0.0099)
Db3	-0.0263**	-0.0277**	-0.0274**	-0.0272**	-0.0440***	-0.0562***
	(0.0108)	(0.0127)	(0.0128)	(0.0128)	(0.0150)	(0.0177)
Db4	-0.0332***	-0.0328**	-0.0303**	-0.0298**	-0.0531***	-0.0578***
	(0.0110)	(0.0134)	(0.0139)	(0.0139)	(0.0171)	(0.0194)
Observations	21,167	19,744	17,021	17,021	18,321	11,516
R-squared	0.1413	0.2763	0.2862	0.2862	0.1493	0.0486
Lender characteristics	No	No	Yes	Yes	Yes	No
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Borrower fixed effects	Yes	No	No	No	No	No
Borrower x time fixed effects	No	Yes	Yes	Yes	No	No
Macroeconomic characteristics	No	No	No	Yes	No	No
Borrower characteristics	No	No	No	No	No	Yes
Country x time fixed effects	No	No	No	No	Yes	Yes
Cluster	bank-borrower	bank-borrower	bank-borrower	bank-borrower	bank-borrower	bank-borrower

Notes: this table presents the estimates of a change in the outcome variable (ΔL) for O-SII banks with different buffer levels. The baseline dummy is represented by those banks that are not O-SII. The dependent variable (ΔL) is the annual logarithmic growth rate of bank lending. Db1 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0% and 0.50%, 0 otherwise. Db2 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0.50% and 1%, 0 otherwise. Db3 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1% and 1.50%, 0 otherwise. Db4 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1.50% and 2%, 0 otherwise. Lender characteristics includes the logarithm of bank total assets, the ratio of equity to total assets, the non-performing loans ratio, the ratio of deposits to total liabilities and the net interest margin. Macroeconomic characteristics includes inflation and the growth of nominal GDP. Borrower characteristics includes operating revenues to total asset ratio, the solvency ratio and the logarithm of firm total assets. Robust standard errors are double-clustered at the bank and borrower level. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 6. O-SII buffer requirements and lending to credit institutions

	(1) ΔL_CI	(2) ΔL_CI	(3) ΔL_CI	(4) ΔL_CI	(5) ΔL_CI	(6) ΔL_CI
Db1	-0.0112**	-0.0093*	-0.0060	-0.0055	-0.0225**	-0.0222**
	(0.0056)	(0.0061)	(0.0063)	(0.0063)	(0.0090)	(0.0093)
Db2	-0.0258***	-0.0216**	-0.0195**	-0.0183**	-0.0538***	-0.0444***
	(0.0087)	(0.0092)	(0.0091)	(0.0091)	(0.0143)	(0.0160)
Db3	-0.0274*	-0.0252*	-0.0243*	-0.0232*	-0.0775***	-0.0722***
	(0.0167)	(0.0168)	(0.0165)	(0.0164)	(0.0241)	(0.0273)
Db4	-0.0492***	-0.0484**	-0.0473**	-0.0463**	-0.1047***	-0.0904***
	(0.0181)	(0.0189)	(0.0190)	(0.0188)	(0.0282)	(0.0323)
Observations	8,621	8,167	6,955	6,955	7,399	5,371
R-squared	0.1199	0.2066	0.2062	0.2065	0.1241	0.0895
Lender characteristics	No	No	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Borrower fixed effects	Yes	No	No	No	No	No
Borrower x time fixed effects	No	Yes	Yes	Yes	No	No
Macroeconomic characteristics	No	No	No	Yes	No	No
Borrower characteristics	No	No	No	No	No	Yes
Country x time fixed effects	No	No	No	No	Yes	Yes
Cluster	bank-borrower	bank-borrower	bank-borrower	bank-borrower	bank-borrower	bank-borrower

Notes: this table presents the estimates of a change in the outcome variable (ΔL_CI) for O-SII banks with different buffer levels. The baseline dummy is represented by those banks that are not O-SII. The dependent variable (ΔL_CI) is the annual logarithmic growth rate of bank lending to credit institutions. Db1 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0% and 0.50%, 0 otherwise. Db2 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0.50% and 1%, 0 otherwise. Db3 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1% and 1.50%, 0 otherwise. Db4 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1.50% and 2%, 0 otherwise. Lender characteristics includes the logarithm of bank total assets, the ratio of equity to total assets, the non-performing loans ratio, the ratio of deposits to total liabilities and the net interest margin. Macroeconomic characteristics includes inflation and the growth of nominal GDP. Borrower characteristics includes operating revenues to total asset ratio, the solvency ratio and the logarithm of firm total assets. Robust standard errors are double-clustered at the bank and borrower level. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 7. O-SII buffer requirements and lending to non-financial corporations

	(1) ΔL_NFC	(2) ΔL_NFC	(3) ΔL_NFC	(4) ΔL_NFC	(5) ΔL_NFC	(6) ΔL_NFC
Db1	-0.0029	-0.0033	-0.0029	-0.0034	0.0021	0.0048
	(0.0024)	(0.0027)	(0.0028)	(0.0028)	(0.0044)	(0.0043)
Db2	-0.0000	-0.0002	-0.0013	-0.0024	0.0031	0.0078
	(0.0028)	(0.0031)	(0.0033)	(0.0034)	(0.0052)	(0.0053)
Db3	0.0014	0.0017	-0.0002	-0.0019	0.0031	0.0066
	(0.0035)	(0.0039)	(0.0043)	(0.0044)	(0.0066)	(0.0069)
Db4	0.0063	0.0069	0.0055	0.0038	0.0087	0.0123
	(0.0048)	(0.0053)	(0.0061)	(0.0061)	(0.0087)	(0.0094)
Observations	7,330	6,850	6,241	6,241	6,633	5,025
R-squared	0.1433	0.3184	0.3285	0.3290	0.1566	0.0203
Lender characteristics	No	No	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Borrower fixed effects	Yes	No	No	No	No	No
Borrower x time fixed effects	No	Yes	Yes	Yes	No	No
Macroeconomic characteristics	No	No	No	Yes	No	No
Borrower characteristics	No	No	No	No	No	Yes
Country x time fixed effects	No	No	No	No	Yes	Yes
Cluster	bank-borrower	bank-borrower	bank-borrower	bank-borrower	bank-borrower	bank-borrower

Notes: this table presents the estimates of a change in the outcome variable (ΔL_NFC) for O-SII banks with different buffer levels. The baseline dummy is represented by those banks that are not O-SII. The dependent variable (ΔL_NFC) is the annual logarithmic growth rate of bank lending to non-financial corporations. Db1 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0% and 0.50%, 0 otherwise. Db2 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0.50% and 1%, 0 otherwise. Db3 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1% and 1.50%, 0 otherwise. Db4 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1.50% and 2%, 0 otherwise. Lender characteristics includes the logarithm of bank total assets, the ratio of equity to total assets, the non-performing loans ratio, the ratio of deposits to total liabilities and the net interest margin. Macroeconomic characteristics includes inflation and the growth of nominal GDP. Borrower characteristics includes operating revenues to total asset ratio, the solvency ratio and the logarithm of firm total assets. Robust standard errors are double-clustered at the bank and borrower level. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 8. O-SII buffer requirement for TLTRO recipients

	Panel A. TLTRO bank lending to credit institutions						Panel B. TLTRO bank lending to non-financial corporations					
	(1) ΔL_CI	(2) ΔL_CI	(3) ΔL_CI	(4) ΔL_CI	(5) ΔL_CI	(6) ΔL_CI	(7) ΔL_NFC	(8) ΔL_NFC	(9) ΔL_NFC	(10) ΔL_NFC	(11) ΔL_NFC	(12) ΔL_NFC
Db1	-0.0307***	-0.0358***	-0.0362***	-0.0381***	-0.0371***	-0.0394***	0.0006	0.0000	0.0003	0.0001	0.0040	0.0011
	(0.0088)	(0.0101)	(0.0119)	(0.0119)	(0.0117)	(0.0119)	(0.0029)	(0.0024)	(0.0027)	(0.0028)	(0.0051)	(0.0033)
Db2	-0.0611***	-0.0735***	-0.0764***	-0.0790***	-0.0762***	-0.0761***	-0.0018	-0.0022	-0.0024	-0.0022	0.0021	0.0005
	(0.0137)	(0.0165)	(0.0185)	(0.0188)	(0.0191)	(0.0201)	(0.0025)	(0.0014)	(0.0019)	(0.0019)	(0.0053)	(0.0027)
Db3 – Db4	-0.1192***	-0.1572***	-0.1652***	-0.1686***	-0.1348***	-0.1351***	-0.0004	-0.0019	-0.0026	-0.0026	0.0050	-0.0007
	(0.0284)	(0.0340)	(0.0390)	(0.0390)	(0.0355)	(0.0366)	(0.0031)	(0.0015)	(0.0020)	(0.0021)	(0.0065)	(0.0044)
Observations	3,263	2,884	2,443	2,443	2,817	2,071	3,454	3,005	2,834	2,834	3,284	3,454
R-squared	0.1532	0.2862	0.2850	0.2861	0.1628	0.1098	0.1788	0.3666	0.3701	0.3706	0.1968	0.1734
Lender characteristics	No	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Borrower fixed effects	Yes	No	No	No	No	No	Yes	No	No	No	No	Yes
Borrower x time fixed effects	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No
Macroeconomic characteristics	No	No	No	Yes	No	No	No	No	No	Yes	No	No
Borrower characteristics	No	No	No	No	No	Yes	No	No	No	No	No	No
Country x time fixed effects	No	No	No	No	Yes	Yes	No	No	No	No	Yes	No

Notes: this table presents the estimates of a change in the outcome variable (ΔL_CI) for O-SII banks with different buffer levels. The Table is divided in two panels. Panel A reports the estimates of TLTRO recipient banks' lending to credit institutions. Panel B reports the estimates for TLTRO recipient banks' lending to non-financial corporations. The baseline dummy is represented by those banks that are not O-SII. The dependent variables ΔL_CI and ΔL_NFC are the annual logarithmic growth rate of bank lending to credit institutions and to non-financial corporations, respectively. Db1 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0% and 0.50%, 0 otherwise. Db2 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0.50% and 1%, 0 otherwise. Db3 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1% and 1.50%, 0 otherwise. Db4 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1.50% and 2%, 0 otherwise. Lender characteristics includes the logarithm of bank total assets, the ratio of equity to total assets, the non-performing loans ratio, the ratio of deposits to total liabilities and the net interest margin. Macroeconomic characteristics includes inflation and the growth of nominal GDP. Borrower characteristics includes operating revenues to total asset ratio, the solvency ratio and the logarithm of firm total assets. Robust standard errors are double-clustered at the bank and borrower level. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 9. O-SII buffer requirement for TLTRO non-recipients

	Panel A. Non-TLTRO bank lending to credit institutions						**Panel B.** non-TLTRO bank lending to non-financial corporations					
	(1) ΔL_CI	(2) ΔL_CI	(3) ΔL_CI	(4) ΔL_CI	(5) ΔL_CI	(6) ΔL_CI	(7) ΔL_NFC	(8) ΔL_NFC	(9) ΔL_NFC	(10) ΔL_NFC	(11) ΔL_NFC	(12) ΔL_NFC
Db1	-0.0062	-0.0073	-0.0088	-0.0064	-0.0208	-0.0072	-0.0168*	-0.0246**	-0.0408***	-0.0439***	-0.0567***	-0.0152
	(0.0076)	(0.0095)	(0.0100)	(0.0101)	(0.0204)	(0.0203)	(0.0089)	(0.0108)	(0.0121)	(0.0123)	(0.0137)	(0.0125)
Db2	-0.0145	-0.0102	-0.0126	-0.0107	-0.0460	0.0091	-0.0122	-0.0198*	-0.0395***	-0.0445***	-0.0637***	-0.0178
	(0.0112)	(0.0126)	(0.0124)	(0.0124)	(0.0448)	(0.0442)	(0.0099)	(0.0117)	(0.0131)	(0.0134)	(0.0150)	(0.0139)
Db3	-0.0015	0.0105	-0.0000	-0.0005	-0.0494	0.0450	-0.0147	-0.0227	-0.0485***	-0.0557***	-0.0817***	-0.0302*
	(0.0191)	(0.0186)	(0.0182)	(0.0183)	(0.0835)	(0.0827)	(0.0119)	(0.0139)	(0.0155)	(0.0161)	(0.0185)	(0.0170)
Db4	-0.0212	-0.0102	-0.0128	-0.0111	-0.0656	0.0564	-0.0040	-0.0121	-0.0381**	-0.0446***	-0.0691***	-0.0241
	(0.0216)	(0.0221)	(0.0201)	(0.0201)	(0.1155)	(0.1152)	(0.0126)	(0.0146)	(0.0163)	(0.0167)	(0.0190)	(0.0175)
Observations	5,342	4,949	4,234	4,234	4,562	5,342	3,865	3,346	2,974	2,974	3,322	2,742
R-squared	0.1426	0.2482	0.2631	0.2637	0.1573	0.1426	0.1915	0.3919	0.4067	0.4076	0.2125	0.0347
Lender characteristics	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Borrower fixed effects	Yes	No	No	No	No	Yes	Yes	No	No	No	No	No
Borrower x time fixed effects	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No
Macroeconomic characteristics	No	No	No	Yes	No	No	No	No	No	Yes	No	No
Borrower characteristics	No	No	No	No	No	No	No	No	No	No	No	Yes
Country x time fixed effects	No	No	No	No	Yes	No	No	No	No	No	Yes	Yes

Notes: this table presents the estimates of a change in the outcome variable (ΔL_CI and ΔL_NFC) for O-SII banks with different buffer levels. The Table is divided in two panels. Panel A reports the estimates of TLTRO recipient banks' lending to credit institutions. Panel B reports the estimates for TLTRO recipient banks' lending to non-financial corporations.. The baseline dummy is represented by those banks that are not O-SII. The dependent variables ΔL_CI and ΔL_NFC are the annual logarithmic growth rate of bank lending to credit institutions and to non-financial corporations, respectively. Db1 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0% and 0.50%, 0 otherwise. Db2 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0.50% and 1%, 0 otherwise. Db3 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1% and 1.50%, 0 otherwise. Db4 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1.50% and 2%, 0 otherwise. Lender characteristics includes the logarithm of bank total assets, the ratio of equity to total assets, the non-performing loans ratio, the ratio of deposits to total liabilities and the net interest margin. Macroeconomic characteristics includes inflation and the growth of nominal GDP. Borrower characteristics includes operating revenues to total asset ratio, the solvency ratio and the logarithm of firm total assets. Robust standard errors are double-clustered at the bank and borrower level. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 10. Robustness checks

	(1) ΔL	(2) ΔL_CI	(3) ΔL_NFC
Panel A. Removing Exposure that can fall below the large exposure threshold			
Db1	-0.0080*	-0.0109	-0.0021
	(0.0050)	(0.0071)	(0.0034)
Db2	-0.0239***	-0.0308***	-0.0020
	(0.0075)	(0.0113)	(0.0017)
Db3	-0.0430***	-0.0482**	-0.0051
	(0.0136)	(0.0194)	(0.0019)
Db4	-0.0490***	-0.0825***	-0.0019
	(0.0146)	(0.0237)	(0.0023)
Observations	14921	5858	6134
Panel B. Removing non O-SII banks that borrow from O-SII banks			
Db1			-0.0006
			(0.0034)
Db2			-0.0012
			(0.0040)
Db3			-0.0002
			(0.0055)
Db4			0.0067
			(0.0085)
Observations			5247
Panel C. Removing G-SIBs			
Db1	-0.0062	-0.0063	0.0009
	(0.0039)	(0.0044)	(0.0075)
Db2	-0.0168***	-0.0196***	-0.0017
	(0.0056)	(0.0063)	(0.0085)
Db3	-0.0194*	-0.1532	-0.0098
	(0.0115)	(0.0125)	(0.0110)
Db4	-0.0229*	-0.0306**	-0.0020
	(0.0131)	(0.0143)	(0.0133)
Observations	9560	4408	1403
Panel D. Removing Countries Applying Score Below the Threshold			
Db1	-0.0129**	-0.0226**	-0.0023
	(0.0055)	(0.0074)	(0.0024)

Db2	-0.0291***	-0.0503***	0.0021
	(0.0091)	(0.0131)	(0.0028)
Db3	-0.0380**	-0.0723***	0.0041
	(0.0160)	(0.0221)	(0.0037)
Db4	-0.0549***	-0.0929***	0.0104**
	(0.0176)	(0.0266)	(0.0101)
Observations	19026	7830	7066
Panel E. Removing Countries Applying Supervisory Judgment			
Db1	-0.0151**	-0.0238***	-0.0029
	(0.0067)	(0.0089)	(0.0031)
Db2	-0.0322***	-0.0530***	-0.0062
	(0.0111)	(0.0155)	(0.0043)
Db3	-0.0421**	-0.0677**	-0.0096
	(0.0202)	(0.0271)	(0.0069)
Db4	-0.0592**	-0.1176***	-0.0090
	(0.0246)	(0.0342)	(0.0089)
Observations	4125	1889	1667
Panel F. Removing Germany, France and Italy			
Db1	-0.0127*	-0.0239*	0.0097
	(0.0070)	(0.0127)	(0.0059)
Db2	-0.0271**	-0.0485**	0.0092
	(0.0116)	(0.0213)	(0.0067)
Db3	-0.0348*	-0.0632*	0.0109
	(0.0199)	(0.0361)	(0.0085)
Db4	-0.0456*	-0.1035**	0.0110
	(0.0239)	(0.0467)	(0.0100)
Observations	5910	2145	1634

Notes: this table presents the robustness checks. All regressions includes bank- and macroeconomic-control variables as well as bank and borrower-time fixed effects. The Table is divided in six panels. Panel A reports the estimates where we remove large exposure that can fall below the large exposure threshold. Panel B reports the estimates where we remove non O-SII banks that borrow from O-SII banks. Panel C reports the estimation when we remove the G_SIIs banks from the sample. Panel D reports the estimates where we remove countries that apply score below the threshold. Panel E reports the estimates where we remove countries that apply supervisory judgment. Panel F reports the estimates where we remove Germany, France and Italy from the sample. The baseline dummy is represented by those banks that are not O-SII. The dependent variable (ΔL) is the annual logarithmic growth rate of bank lending. Db1 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0% and 0.50%, 0 otherwise. Db2 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 0.50% and 1%, 0 otherwise. Db3 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1% and 1.50%, 0 otherwise. Db4 is a dummy that takes value 1 if a bank has been assigned a capital buffer between 1.50% and 2%, 0 otherwise. Lender characteristics includes the logarithm of bank total assets, the ratio of equity to total assets, the non-performing loans ratio, the ratio of deposits to total liabilities and the net interest margin. Policy characteristic is the number of years between the announcement date and the fully loaded period. Macroeconomic characteristics includes inflation and the growth of nominal GDP. Borrower characteristics includes operating revenues to total asset ratio, the solvency ratio and the logarithm of firm total assets. Robust standard errors are double-clustered at the bank and borrower level. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

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