Quantitative Easing, Bank Lending, and Macroprudential Regulation

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Abstract

We study whether time-varying macroprudential regulation that relies on historical cost accounting (HCA) to insulate banks' net worth from financial market volatility—a policy widely used in the European Union—impairs the transmission of quantitative easing (QE) through the bank lending channel. Using detailed supervisory data from Italian banks and taking advantage of a shift in the macroprudential regime, we find that HCA significantly mutes the impact of QE. Our results suggest that, while HCA-based macroprudential regulation can insulate banks' balance sheets during periods of distress, it also impairs the effectiveness of monetary policy in reducing firm credit constraints.

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1. Introduction

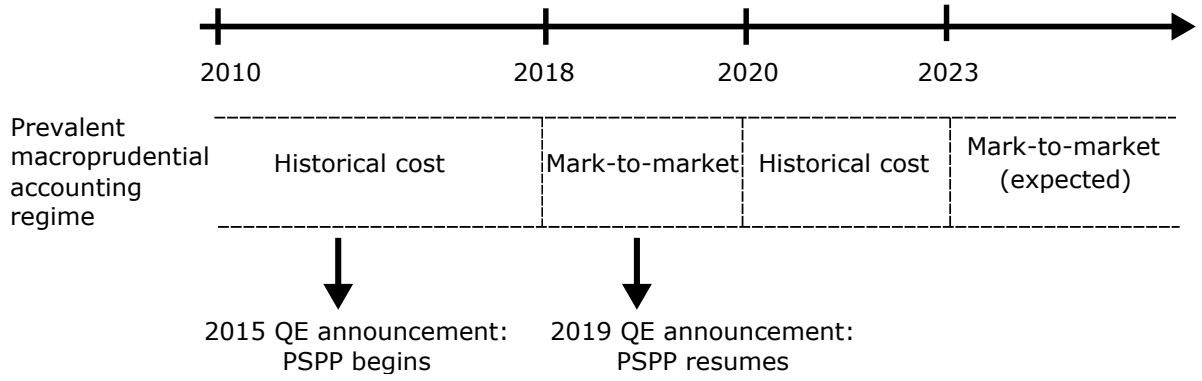
Macroprudential policy and quantitative easing (QE) are now both important components of central banks' toolkits. Both types of policies are intended in part to stabilize the net worth of financial institutions and control the supply of credit to the broader economy.[1] There is also a growing consensus in the theoretical literature that the joint implementation of these tools can further dampen the real effects of adverse shocks (Farhi and Werning 2016, Van der Ghote 2021). However, empirical evidence on how these policies might interact and jointly determine the supply of bank credit remains limited. This paper helps to fill this gap. It shows that time-varying macroprudential policies that rely on accounting regulation to insulate banks' net worth from asset price volatility can impede the transmission of unconventional monetary policy through the bank lending channel.

Time-varying macroprudential policies based on accounting regulations are currently in use in the European Union and have been employed for more than a decade (Figure 1). These policies determine the accounting method—*historical cost accounting* (HCA) or *mark-to-market accounting* (MMA)—banks use to value their assets when computing regulatory net worth. During the sovereign crisis of the early 2010s, the prevailing macroprudential framework used HCA to value most sovereign assets, directly insulating European banks' net worth and lending capacity from volatility in sovereign bond prices. These regulations were withdrawn in 2018, allowing most asset price changes to pass through onto banks' balance sheets. The regulations changed again in 2020 in response to COVID-19, with a temporary expansion of HCA until the end of 2022.

Our empirical setting uses the ECB's largest quantitative easing (QE) program—the Public Sector Purchase Program (PSPP)—together with the changes in macroprudential regulation (Figure 1). In particular, we study the introduction of the PSPP in January 2015—when HCA was used to value most sovereign securities—and the resumption of the PSPP in 2019—when MMA was more prevalent. These policy changes along with credit register data provide an ideal empirical setting to study the interaction of macroprudential policy and QE on bank lending.

[1] See for example the theoretical arguments in (Gertler and Karadi 2011, He and Krishnamurthy 2013, Brunnermeier and Sannikov 2014, Di Tella 2019).

Figure 1: Macroprudential accounting regulation for sovereign securities, and QE announcements.



The figure shows the evolution of some key aspects of the European Union macroprudential accounting regime that banks use to value their holdings of sovereign securities, when computing regulatory net worth (see Section 2 for more details) and the two main announcements of the PSPP—the ECB's largest QE program.

The accounting treatment in the macroprudential regime can determine the impact of QE on bank lending via the bank recapitalization channel. This channel observes that by increasing the price of sovereign debt, central bank asset purchases can increase the net worth of banks and, thus, their lending capacity. However, under the HCA rules in place in 2015, even if a bank had substantial balance sheet exposure to sovereign assets scheduled for purchase, QE-related asset price increases would not directly affect bank regulatory net worth and therefore might have had little or no impact on lending. Differently, because of the subsequent shift to MMA for most sovereign assets, the 2019 resumption of QE should have had a larger impact. To be sure, the importance of the macroprudential regime could be muted by QE effects being transmitted via other channels that operate through the market value of all assets held by banks or the enhanced liquidity value of the securities to be purchased.[2] It is thus an empirical question whether and how much macroprudential regulations that use HCA to stabilize banks' net worth also affect the QE bank lending channel.

There are several challenges in identifying the impact of macroprudential policy and QE on bank loan supply. A key issue is the endogenous response of both macroprudential and monetary

[2] For instance, a higher market value of banks could lower the cost of raising new capital, which could in turn boost lending.

policy to current and expected economic conditions (Nakamura and Steinsson 2018). For example, the risk of deflation and weak credit supply in the aftermath of the EU sovereign and banking crisis spurred the 2015 PSPP announcement, and improved economic conditions led to the 2018 change in macroprudential policy that permitted the greater pass-through of sovereign debt prices onto banks' net worth. A related concern is that QE is implemented alongside other policies, making it hard to identify the effect of QE from other policy interventions. In addition, measurement error can contaminate inference. Accounting-based macroprudential policies are highly targeted, so that changes in the price of an asset can affect a bank's net worth very differently depending on where on the balance sheet the asset is recorded. For example, different macroprudential accounting rules apply for an asset recorded in the *trading book* on a bank's balance sheet versus the same asset recorded as *held to maturity*. As a result, analyses based on a simple aggregation of a bank's asset holdings might have low power.

We address these issues by using monthly firm-bank-level data from the Italian credit register and monthly granular supervisory bank balance sheet data. The relatively high frequency of monthly data reduces the risk of contamination from other policies, and access to credit register data and a suite of firm-bank-month-year fixed effects address endogeneity concerns by non-parametrically absorbing the variation in latent demand at the firm-month-year level. In addition, granular supervisory data on the asset holdings of Italian banks, including the specific location of these assets on banks' balance sheets and their accounting treatment under the prevailing macroprudential regime, help precisely measure the pass-through of sovereign debt prices on each bank's regulatory net worth.

We find that macroprudential regulations that use HCA to insulate banks' balance sheets from sovereign asset price movements also mute and segment the pass-through of QE onto bank lending. Identifying bank exposure to the PSPP based on which sovereign assets are valued at HCA versus MMA as per capital regulation, we find that only banks exposed to the PSPP through their holdings of MMA sovereign assets increased lending after the PSPP was announced. This finding holds *both* in 2015 and 2019, that is, under two very different macroprudential regimes. However, the magnitude of the effects is very different when comparing the 2015 and 2019 announcements

because of the different macroprudential regimes.

The 2015 effect of the PSPP was very small whereas the 2019 effect was much bigger. In 2015, given the widespread use of HCA, only sovereign securities classified in the *trading book* were valued using MMA. Because of this narrow exposure—very few banks had significant trading book holdings—the effect of the 2015 PSPP on bank lending was only €231 million, according to a back-of-the-envelope calculation. In 2019, the effect was much bigger because MMA covered a much larger fraction of eligible securities—not only *trading book* sovereign securities but also those classified as *available-for-sale*, which account for a large fraction of the holdings of PSPP-eligible securities in the Italian banking system. Consistent with the greater coverage of MMA, we detect a 22-fold larger lending response in 2019 relative to 2015, or about €5.2 billion, immediately after the restart of the PSPP.

We also find that macroprudential accounting rules affect the portfolio rebalancing channel of QE. Banks with larger holdings of marked-to-market sovereign securities sold more PSPP-eligible securities than banks with fewer holdings, with the magnitude again being much bigger in 2019. In particular, banks' exposure to the PSPP led to the sale of €3.8 billion of eligible securities in the three months after the PSPP resumed in 2019—about 60% of the approximately €6 billion in Italian sovereign securities that the ECB purchased during that period.

We then provide several additional analyses and robustness checks. An instrumental variables approach based on lagged exposure helps to rule out the concern that some banks might anticipate the QE announcement or the change in the macroprudential regime and self-select into exposure or reclassify securities from HCA to MMA—the results do not change. The results are also robust when we extend the sample to include over 50 million firm-bank-time observations—20 million for 2015 and 30 million for 2019— to address seasonality as well as the endogeneity of the change in the macroprudential regime itself. Also, we show that the main result is stronger for less capitalized banks, consistent with the hypothesized theoretical mechanism (i.e., the bank recapitalization channel). The extensive margin results based on loan application data are also similar. And among originated loans, we find that interest rates declined by about 0.9 and 1.5 percentage points among exposed banks, relative to less exposed ones, in response to the 2019 and

2015 announcement, respectively. The reduction in rates, together with the increase in the quantity of loans, suggests that we are identifying changes in *supply* as opposed to latent movements in credit demand.[3]

We also test whether differences in banks' exposure to the PSPP induce substitution effects: Firms might replace loans from non-exposed banks with loans from exposed banks. Substitution would dampen the aggregate effects of the policy, as exposed banks would expand lending at the expense of non-exposed banks. Our substitution tests exploit the fact that banking competition in Italy occurs locally. We show that lending to existing customers does not drop when bank branches of non-exposed banks are located close to highly exposed competitors. This finding is consistent with the view that existing credit relationships are sticky in the short run. We find, however, a reduction in lending to new customers when a bank faces highly exposed competitors (i.e., PSPP exposed banks attract new business at the expense of non-exposed banks), but the consequences on overall lending are very weak.

To our knowledge, this paper is the first to study how time-varying macroprudential regulations that rely on HCA to stabilize banks' net worth can directly shape the transmission of unconventional monetary policy, showing that, while HCA might insulate the banking system from increased sovereign yields, it reduces the effectiveness of QE in relaxing firm credit constraints. These results can help discipline quantitative models of the monetary transmission mechanism and bank lending (Gertler and Karadi 2011, Gertler and Kiyotaki 2015), and can help inform theoretical models that study the tradeoff between HCA and MMA and the broader effects of these two accounting regimes.[4] This evidence also informs theories of macroprudential regulation and richer models that study the welfare consequences of various stabilization policies—countercyclical capital buffers, household leverage constraints, and HCA versus MMA

[3] Any latent demand explanation would thus have to posit that latent loan demand increased after the PSPP announcement, both for firms matched to banks exposed to the PSPP and for firms borrowing for the first time from exposed banks, and both in 2015 and 2019. This possibility is highly unlikely and is inconsistent with the reduction in interest rates that we document—an increase in latent demand should produce an increase in interest rates.

[4] Some have argued that MMA propagated shocks through the financial system in 2008-2009—see (Allen and Carletti 2008, Plantin, Sapra et al. 2008) for models that discuss the potential costs of MMA in bank capital regulation, while (Ellul, Jotikasthira et al. 2015) provide evidence on some of the potential drawbacks of HCA in the context of the US insurance industry.

rules. The results also add to the ongoing policy debate, as policymakers might continue to rely on HCA expansion to limit the transmission of increased sovereign yield onto the banking system.

We build on a large literature and the next section precisely places our contribution in context. Section 2 provides institutional details about the macroprudential accounting regulations based on HCA, Section 3 describes the data, and Section 4 presents the main results. Section 5 examines substitution at the firm- and province-level, and Section 6 concludes.

1.1 Related Literature

The literature that studies the interaction between macroprudential and monetary policy is mostly theoretical or based on structural models (Farhi and Werning 2016, Van der Ghote 2021). A few empirical studies have analyzed this interaction, but their approaches and results are very different from ours. (Aiyar, Calomiris et al. 2016) find little evidence of interaction between conventional monetary policy and capital requirements. (Altavilla, Laeven et al. 2020) and (Bruno, Shim et al. 2017) study whether accommodative macroprudential environments tend to boost the effects of monetary policy easing. However, they use broad indexes of macroprudential regulation and monetary policy easing, rather than studying specific policies as we do, and they do not study the time-varying macroprudential accounting rules at the center of our work.[5]

We also build on the growing literature on QE. In the case of the PSPP, previous studies have focused mostly on the asset price responses to the program's announcement. Notably, the evidence in (Andrade, Breckenfelder et al. 2016) and (Altavilla, Carboni et al. 2021) suggest that the PSPP's announcement led to a drop in European sovereign yields, and an increase in asset prices, including the stock prices of banks most exposed to the PSPP. Extrapolating from this asset price response, the model-based results in (Andrade, Breckenfelder et al. 2016) suggest that the PSPP led to an increase in output in part through the bank lending channel. However, the actual transmission of these policies onto bank loan supply and the overall efficacy of QE remain open questions—see the survey in (Jancokova, Fabo et al. 2021). Our macroprudential results suggest in part why the

[5] (Jiménez, Ongena et al. 2017) is a classic reference on macroprudential regulation using credit register data, but their focus is on countercyclical capital buffers. Some macroprudential polices also encompass household leverage—see for example (Defusco, Johnson et al. 2019).

effects of QE can be heterogenous and difficult to detect.

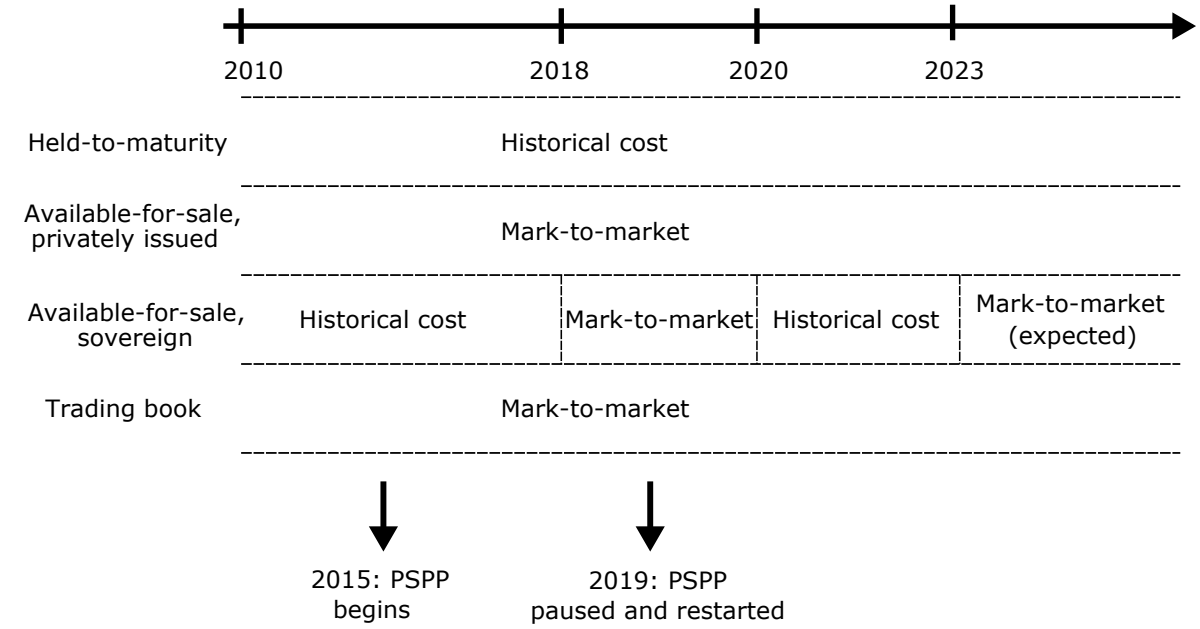
Beyond macroprudential channels, the evidence in (Peydró, Polo et al. 2021) observes that the transmission of monetary policy onto bank lending can be impaired if banks hoard liquidity or engage in securities trading instead of lending—see also (Abbassi, Iyer et al. 2016) in the case of German data. And using similar Italian micro data to us, (Peydró, Polo et al. 2021) observe that banks more exposed to the PSPP may have engaged in more securities trading. Those authors do not directly measure the effects of the PSPP onto loan supply itself, nor do they study the role of macroprudential regulations.

Our analysis of the bank-lending channel of QE is also closely related to work based on US data. (Foley-Fisher, Ramcharan et al. 2016, Darmouni and Rodnyansky 2017) and (Luck and Zimmermann 2018).[6] However, these results remain subject to debate and appear sensitive to the choice of firms used in the sample and the definition of the QE exposure counterfactual.[7] Our micro credit register data help us to make progress relative to studies that use US data. In particular, because we observe the near-universe of Italian firms, our results are less likely to be sensitive to the choice of firms in any given sample. The credit register data also identify firm credit applications, allowing us to study the effects of the PSPP at the extensive margin. Unfortunately, we are aware of no such data for the US. Moreover, with detailed supervisory data on asset holdings across the balance sheet, we can make progress in understanding the effects of heterogeneity in the application of MMA and HCA in asset valuation. The relatively high frequency of the data—monthly—also help us to be clear on the counterfactual and exclude alternative interpretations stemming from other economic news.

Our approach builds on the broader literature examining the bank lending channel using micro-economic data. (Jiménez, Ongena et al. 2012) is an important antecedent, as they use Spanish credit register data to examine the effects of monetary policy at the extensive margin—see also (Jiménez, Ongena et al. 2014, Jiménez, Mian et al. 2020). Other classic studies in this literature include (Kashyap and Stein 2000) and (Peek and Rosengren 2000), while recent work by (Drechsler, Drechsel et al. 2016) focus on how other ECB policies impact bank lending.

[6] There is also a sizeable literature on the transmission of QE through the mortgage and housing channel. See for example (Di Maggio, Kermani et al. 2017, Beraja, Fuster et al. 2019, Palmer, Kermani et al. 2020, Ramcharan 2020).
[7] For example, instead of using time dummies to denote QE, (Chakraborty, Goldstein et al. 2020) use quarterly Fed asset purchases and a sample of larger firms in the US. They find that QE-exposed banks substituted away from lending to firms and towards mortgage lending to households, which in turn actually decreased firm investment.

Figure 2: Security holdings and regulatory accounting rules



This figure shows how identical assets on the balance sheet are valued differently depending on their regulatory classification. Between 2010-2018, sovereign assets classified as available for sale were valued at historical cost. Between 2018-2019, sovereign assets classified as available for sale were then marked to market. In 2020, amid COVID, regulators have introduced a *prudential filter* that allows banks to value again available-for-sale sovereign assets at historical cost, based on the market value as of December 31, 2019. Assets classified as held to maturity are always valued at historical cost, while those in the trading book are always marked to market.

2. Background: Macroprudential regulation and accounting rules

Macroprudential regulations include the accounting rules used by banks to value their asset holdings for the purpose of computing regulatory capital and measuring whether banks meet capital requirements. This section provides a bird's-eye view of these rules, focusing on the main elements that are relevant for our analysis.

A security can be valued using historical cost accounting (HCA) or mark-to-market accounting (MMA) for the purpose of capital requirement regulation. Under HCA, the security is valued using the purchase price paid by the bank. Thus, changes in market prices do not affect the bank's balance sheet nor regulatory net worth. In contrast, under MMA, the security is valued using current market prices, and changes in market condition have an impact on regulatory net worth. Regulators have used HCA as a time-varying macroprudential tool to insulate banks' balance sheet from market volatility by expanding the scope of HCA and reducing that of MMA during crisis times—the Euro area sovereign crisis of the early 2010s and the COVID-19 crisis.

Whether a security is valued using MMA or HCA depends on how a bank classifies the security on its balance sheet—holdings of the same securities can be valued differently depending on their classification. In general, banks can classify a security in one of three ways: *held to maturity*, *available for sale*, or at *fair value through profit or loss*—the latter is often referred to as *trading book*.[8] If the bank plans to hold the security until maturity, it typically classifies it as held to maturity. If the bank intends to keep the security on its balance sheet but wants to keep the option to sell it, it typically classifies it as available for sale. And finally, securities that are traded more frequently are typically classified as part of the trading book. Note that regulators—in the case of Italian banks, the Bank of Italy—require banks to classify securities based on banks' plans to hold or trade them. Banks' security classifications are heavily scrutinized by regulators and, thus, systematic misclassifications are unlikely.[9] Key for our analysis is that these assignments are relatively sticky, as banks cannot easily re-assign securities without prior regulatory approval.[10]

The macroprudential accounting rules that apply to Italian banks are summarized in Figure 2. The rules depend on whether a security is classified as held to maturity, available for sale, or in the trading book. The rules governing held-to-maturity and trading book securities are similar for sovereign and privately issued securities and have been relatively unchanged over time. Held-to-maturity securities are valued using HCA and trading book securities are valued using MMA.[11]

For available-for-sale securities, the accounting rule depends on the issuer—a sovereign versus a private entity—and has changed over time as a time-varying macroprudential tool. For privately issued securities categorized as available for sale, regulators essentially require MMA. But for sovereign securities issued by Euro-area central governments—which correspond to those that are eligible to be purchased under the PSPP—regulators have applied different regimes over time. To

[8] Throughout the paper, we use the terminology based on the IAS 39 accounting framework. IFRS 9, which has been applied since 2018, says that an entity can classify its securities in three ways: amortized cost, fair value through other comprehensive income, and fair value through profit or loss. We map these categories to held to maturity, available for sale, and trading book, respectively.

[9] In the case of available-for-sale versus trading book, if a bank were to classify securities as available-for-sale but then trade them frequently—as if they were in the trading book—regulators can flag this behavior and take corrective actions.

[10] Under the IAS 39 rules in place until 2018, the reclassification of a held to maturity security is generally not allowed and, if it takes place, it can trigger the re-evaluation of all banks' holdings based on market prices—this trigger is part of the so-called "tainting rule". Under IFRS 9, in place since 2018, reclassifications are only possible when an entity changes its business model for managing financial assets, such as in the event of mergers and acquisitions.

[11] More precisely, held-to-maturity securities are valued at amortized cost, and trading book securities are valued at fair value. However, throughout the analysis, we use the more general terms HCA and MMA to keep the exposition simple.

stabilize the banking system from the effects of the sovereign crisis, during the early 2010s and until the end of 2017, regulators permitted banks to use HCA for sovereign securities.[12] As of 2018, the IFRS 9 accounting framework became effective, requiring all available-for-sale securities to be valued using MMA, including sovereign ones. But as the COVID-19 crisis hit in 2020—after the end of our sample period—European regulators allowed banks to use again HCA for available-for-sale securities.[13]

This regulatory structure creates variation in the accounting rule used to classify sovereign securities—both at any given point in time across classifications, and over time for the available-for-sale classification. Our analysis exploits these variations and studies how they impact the transmission channel of quantitative easing on to bank lending. In particular, the first PSPP announcement took place in January 2015, when only trading book sovereign securities had to be marked to market, and the pause and restart of the PSPP occurred in 2019, when both available-for-sale and trading book sovereign securities had to be marked to market. That is, in addition to the different classification at any point in time, we also take advantage of the switch of available-for-sale sovereign securities from HCA in 2015 to MMA in 2019. Moreover, micro data observed at a relatively high frequency help us control for the latent demand and aggregate factors that precipitated these regulatory shifts. We describe these data next.

3. Data

On January 22, 2015, the ECB announced the PSPP program—to be started the following March—consisting of the purchases of about €50 billion per month of Euro-denominated debt issued by Euro-area central government and supranational institutions with residual maturity

[12] Formally, regulators allowed banks to omit unrealized gains and losses resulting from fair value accounting from the income statement and from the computation of regulatory capital. This is equivalent to using HCA for the purpose of computing regulatory capital and, thus, we simply refer to this rule as HCA. In addition, there was a transition period between 2016 and 2018 in which an increasing share of unrealized gains and losses had to be accounted for in the computation of the regulatory capital. See CEBS (2004) "*Guidelines on prudential filters for regulatory capital*;" Regulation (EU) No 575/2013 (page 508, Article 467); and Bank of Italy "*Disposizioni di vigilanza del 18 maggio 2010. Patrimonio di vigilanza – filtri prudenziali.*"

[13] Formally, regulators have introduced a so-called *prudential filter*, allowing unrealized gains and losses accumulated since December 31, 2019, to be excluded from the computation of regulatory capital. The filter is scheduled to be phased out by the end 2022. See Regulation (EU) 2020/873 of June 24, 2020, EBA guideline EBA/GL/2020/11, and Bank of Italy "*Comunicazione del 23 dicembre 2020 - Attuazione per gli intermediari finanziari degli Orientamenti dell'Autorità bancaria europea relativi agli obblighi di segnalazione inerenti alle disposizioni contenute nel Regolamento 873/2020 (c.d. CRR Quick-fix)*."

between 2 and 30 years.[14] The program was paused at the end of December 2018, and then the ECB announced on September 12, 2019, a restart as of November of that year.[15]

The impact of the PSPP on bank lending would be expected to vary depending on a bank's holdings of securities eligible for purchase under the PSPP ("eligible securities") and, possibly, on how banks' classify these securities—which in turn determines the amount of securities that are valued at historical cost versus marked to market. Measuring this cross-sectional variation in bank exposure to the PSPP and disentangling any supply effects from firm demand and other latent factors require detailed micro-data. This subsection describes the data in detail. We draw on several sources of data, primarily collected by the Bank of Italy.

First, we use the Italian central credit register, which contains information for each firm-bank lending relationship. The credit register is a monthly panel dataset at the firm-bank-time level. That is, each entry represents the amount of lending made by a particular bank to a particular nonfinancial firm in a given month. All loans above €30,000 are included in the register, thereby making the coverage near-universal. Second, we use Taxia and AnaCredit, two datasets with information collected by the Bank of Italy, to retrieve interest rate data on new term loans. Taxia has data for 2015 but only at a quarterly frequency, whereas AnaCredit covers 2019 and data are available at monthly frequency. Third, we use the Initial Information Service (IIS) dataset, which records the instances in which a bank accesses the credit history of a firm—typically, when a firm applies for new credit from a bank it was not previously borrowing from. Fourth, we use the Bank of Italy Credit and Financial Institutions' Supervisory Reports to obtain banks' balance sheet data. A key element of these data is represented by banks' security holdings at the ISIN level, and for each ISIN, the breakdown of the holdings classified as held to maturity, available for sale, or in the trading book. This level of granularity allows us to construct each banks' measure of exposure

[14] Because the exact criteria for international institutions were not fully clarified at the time, we consider eligible the debt of supranational institutions with main headquarter in a euro area country. See the technical annex at https://www.ecb.europa.eu/press/pr/date/2015/html/pr150122_1.en.html. In addition, the securities had to fulfill the collateral eligibility criteria for the ECB and must have a credit rating of at least CQS3 (i.e., Credit Quality Step 3). This corresponds to at least BBB- for S&P's and Fitch, and Baa3 for Moody's.

[15] When the PSPP restarted in 2019, debt issued by Euro-area local governments had become eligible to be purchased under the program too. See Decision (EU) 2015/2464 of the European Central Bank of 16 December 2015.

to the 2015 and 2019 QE policy announcements. Fifth, we use security prices from the Central Security Database maintained by the European System of Central Banks to study banks' trading activity.

In most of our analysis, we work with monthly data over a 12-month window around the QE-announcement dates (i.e., around September 12, 2019, and January 22, 2015), and we extend the sample period for some robustness analyses. We focus on banking groups (hereinafter referred to as "banks") for which the bank holding company is a joint stock company. That is, we exclude mutual and cooperative banks because of the different regulations to which they are subject. We also drop foreign banks, leaving our final sample at 90 banks for 2019 and 95 banks for 2015. Our focus on banking groups (as opposed to single banks) is motivated by the fact that key regulations such as capital requirements are checked by regulators at the group level.[16] Our approach is also similar to that used in recent papers using Italian banking data, such as (Bottero, Minoiu et al. 2020) and (Benetton and Fantino 2021).

In Table 1, we provide some key summary statistics about the firm-bank lending relationships, the loan application data from the IIS, and the interest rate data. Our main analysis uses the growth rate of the amount borrowed for each firm-bank pair with an ongoing lending relationship. Focusing on firms with at least two lending relationships (Khwaja and Mian 2008), we have access to more than eight million observations for the 2019 episode and six million for 2015.

Table 2 contains some key summary statistics about banks in our sample and show that holdings of PSPP-eligible securities were substantial. Banks held 17.13% and 11.45% of assets in securities eligible to be purchased under the PSPP prior to the 2019 and 2015 announcement, respectively. Holdings of eligible securities valued at historical cost were 11.12% and 11.00% in 2019 and 2015, respectively, and holdings of eligible securities marked-to-market were 6.01% and 0.45% in 2019 and 2015, respectively. The 2015 mark-to-market figure appears small, as it includes only securities in the trading book as discussed in Section 2, but we observe that there is

[16] Because of the regulatory approach, banks within the group do not need to meet capital requirements individually. This implies, for instance, that a credit expansion can be carried out only by some banks that are part of the group without the need to observe within-group borrowing and lending, which would cancel out anyway when regulators check group-level capital ratios.

a high degree of heterogeneity across banks which gives rise to a large cross-sectional variation—the coefficient of variation is in fact higher in 2015 than in 2019. We also find substantial heterogeneity when using a dummy measure of exposure for both 2019 and 2015, which we use to provide robustness analyses to control for possible noise and outlier effects (see Sections 4.1 and 4.1.2 for the definition of the dummy measures). In particular, before the 2015 announcement, banks classified as exposed based on this dummy held 3% of assets or 41% of the trading book in eligible securities, in comparison to 0.01% and 6% for banks classified as non-exposed.

Table 2 also reports a list of other variables that we use throughout our analysis. In particular, we include a list of standard balance sheet items as well as other variables that capture banks' exposure to ECB policies other than the PSPP and that we use in our extensive list of robustness checks.

4. Macroprudential regulation and the impact of QE on credit supply

We begin by analyzing the impact of the PSPP announcement on bank lending and how it is mediated by macroprudential accounting regulation. Our main analysis in Sections 4.1 and 4.2 focuses on the effects of the 2019 and 2015 PSPP announcements on pre-existing lending relationships (i.e., the intensive margin), respectively. We then show in Section 4.3 that banks' anticipation of the announcements are not a concern and do not affect our results (we use an instrumental variable approach) and that the results are not the byproduct of seasonality effects or latent factors that led to the change in the macroprudential regime. We conduct additional robustness checks in Section 4.4 and 4.5 to control for variables that might be related with banks' exposure to the PSPP and for the possible effects of other policies.

4.1 The effects of the PSPP under the 2019 macroprudential regime

Models that emphasize the "recapitalization channel" of QE predict that the macroprudential regime can determine whether central bank asset purchases affect a bank's net worth and loan supply. Banks more exposed to the PSPP would likely experience the biggest increase in net worth

on account of the PSPP asset purchases, and thus expand loan supply the most. We use supervisory data on banks' detailed asset holdings to measure PSPP exposure, and the research design combines the cross-sectional variation in banks' exposure to the PSPP with high frequency (monthly) data on lending to measure the importance of this recapitalization channel. This cross-sectional variation in a bank's PSPP exposure stem from its share of assets eligible for purchase under the PSPP and valued using MMA under the prevailing macroprudential regime.

The endogenous variation in loan demand along with contamination from other central bank policies can make it difficult to interpret the evidence. Endogenous loan demand can arise if banks exposed to the PSPP are also matched to firms with greater loan demand. In this case, any increase in loan growth might reflect latent demand rather than the causal effect of the PSPP on loan supply. Other ongoing central bank policies can also influence loan supply, making it hard to distinguish the effects of the PSPP. In addition, the anticipation of the PSPP can yield biased inference due to self-selection. Banks for example can self-select into "exposure" by acquiring eligible assets or tilting their portfolio toward marked-to-market holdings.

We therefore combine the bank-level variation in PSPP exposure with monthly lending data from the credit register at the bank-firm level within a difference-in-difference framework to address these identification challenges. Our difference-in-difference research design uses firm-by-year-month fixed effects to absorb non-parametrically loan demand at the firm level at the monthly frequency. This approach uses firms borrowing from two banks within the same month, and by holding firm loan demand constant over a month, can identify whether the PSPP elicited a bank lending supply response (Khwaja and Mian 2008). Also, by using a narrow time window around the PSPP, the research design reduces concerns that the estimates reflect other ECB policies, such as negative interest rates and the targeted longer-term refinancing operations (Andreeva and García-Posada 2021). Note further that because the Italian credit register contains the near-universe of these bank-firm credit relationships, we can measure the effects of QE on business lending more completely than inferring a treatment effect based on a selected sample of larger firms, usually from DealScan or through regulatory data in the US.

To be clear about the research design at the intensive margin, the dependent variable is the growth rate in lending: The change in the log of disbursed loans from bank *b* to firm *f* at time *t*, in comparison to *t*-1, $\log(L_{b,f,t}) - \log(L_{b,f,t-1})$. We use the specification

$$\Delta \log L_{b,f,t} = \sum_{\tau \neq 2019m8} \beta_\tau \times I_\tau \times QE_b + \sum_{\tau \neq 2019m9} \gamma_\tau \times I_\tau \times Y_b + \delta Z_{b,t} + \psi_b + \psi_{f,t} + \varepsilon_{b,f,t}. \quad (1)$$

The variable QE_b is a measure of a bank's exposure to the PSPP based on the bank's holdings of securities eligible for purchase under the PSPP in the month before the announcement. Thus, in the case of the September 2019 announcement, QE_b is computed using banks' asset holdings at the end of August 2019. We interact this variable with a set of time dummies I_τ, one for each month, dropping the one that corresponds to the pre-announcement month. Thus, our coefficients of interest are the β_τ, which capture the effects of the PSPP announcement on bank lending supply and allow us to check for any possible pre-trend in lending growth. The terms ψ_b and $\psi_{f,t}$ are bank and firm-by-time fixed effects, respectively. Firm-by-time fixed effects $\psi_{f,t}$ allow us to control for demand factors and standard errors are clustered at the bank level.

Even with this suite of fixed effects, other factors that correlate with a bank's exposure to the PSPP could also affect equilibrium lending growth right at the time of the PSPP's announcement. To exclude alternative interpretations, the benchmark specification includes two controls. First, Y_b denotes bank size using the log of total assets. Second, because bank borrowing from the ECB has been shown to independently affect bank behavior, we include the log change in the dollar value that bank *b* borrows from the ECB at time *t*, denoted by $Z_{b,t}$. Other controls, including those related to banks' characteristics and banks' exposure to other ECB policies (Drechsler, Drechsel et al. 2016), are added in the robustness checks of Sections 4.4 and 4.5.

To illustrate the importance of the macroprudential regime in shaping the transmission of the PSPP onto loan supply, we first follow the literature and begin with the broadest exposure definition: The ratio of a bank's securities that are eligible to be purchased under the PSPP to total

bank assets (Darmouni and Rodnyansky 2017, Luck and Zimmermann 2018). Note that this broad exposure measure, defined as all eligible assets to total assets, ignores any accounting heterogeneity in the valuation of sovereign assets; it does not differentiate between sovereign assets that are valued based on HCA and those valued using MMA under the prevailing macroprudential regime. As noted before, we compute the broad measure of exposure as of the end of the month before the announcement—August 2019. Italian banks hold a large amount of sovereign securities, and in the month before the 2019 PSPP announcement, they had on average 17.13% of assets in PSPP-eligible securities.

Column 1 of Table 3 shows the results using the broad measure of exposure to the PSPP. We find no evidence that broad exposure to the PSPP is associated with an increase in lending after the announcement. The point estimates are small and show no clear differences between the pre- and post-announcement periods. Formally, we find a significant albeit small pre-trend (average March-July 2019 = 0.07, p-value = 0.00), and the coefficient on the announcement month—September 2019—is not statistically different from the March-July 2019 average (difference = 0.04, p-value = 0.18).

Column 2 uses supervisory data to create measures of exposure that account for the macroprudential accounting regulation in place in 2019. To gauge the salience of mark-to-market versus historical cost accounting in shaping the impact of the PSPP on lending, column 2 of Table 2 uses an exposure measure that includes only eligible securities that are marked to market. Based on the prevailing 2019 macroprudential rules, sovereign securities are marked to market if classified as available-for-sale or held in the trading book, which jointly account for 6.01% of total assets.

The results using only eligible securities that must be marked to market are drastically different from those derived before. Column 2 of Table 3 shows that banks exposed to the PSPP via their holdings of marked-to-market securities increased lending at the intensive margin almost immediately upon the PSPP's announcement. This measure of exposure also shows no trend difference in lending growth between exposed and non-exposed banks in the period before the PSPP announcement (average March-August 2019: 0.08, p-value 0.21), and the September 2019

coefficient is significantly greater than the March-August 2019 average (difference=0.17, p-value: 0.01). Column 2 also shows a positive effect in December 2019. This finding is likely related to the actual restart of the purchases—we return to the effect of the purchases on banks' portfolio rebalancing choices in Section 5.

A conservative estimate—based on the September 2019 effect—implies an increase in loan supply of about €5.2 billion, according to a back-of-the-envelope calculation based on the counterfactual in which all the banks have zero exposure. As a check, column 3 of Table 3 jointly includes two possible exposure measures—the same one used in column 2 and based on eligible securities that are mark to market (i.e., those classified as available-for-sale or in the trading book), and a second one based on eligible securities valued at historical costs (i.e., holdings classified as held-to-maturity). Both exposure measures are interacted with the time dummies centered on the PSPP announcement month. The coefficients of the mark-to-market exposure are essentially unchanged, and Appendix A shows that the exposure based on securities valued at historical cost generates results similar to those based on the broad measure of exposure—an insignificant lending response.

To deal with possible noise and outlier effects, column 4 of Table 3 replicates column 2 using a dummy to compare banks in top tercile of the exposure distribution with those in the bottom tercile, as in e.g. (Chakraborty, Goldstein et al. 2020). The results are essentially the same as those derived using the continuous exposure measure. In particular, the most exposed banks—those in the top tercile—increase lending supply by 2.66 percentage points in the month after the 2019 PSPP announcement, relative to less exposed ones. We again find no evidence of any significant difference in loan growth across banks in the period before the announcement: the average of the PSPP exposure coefficients in March-August 2019 is 0.55 (p-value=0.39).

We conduct a long list of robustness checks in Sections 4.3-4.5, and we provide a short recitation here. The results are not affected by anticipatory biases. The mark-to-market exposure measure is very persistent over time (the autocorrelation coefficient in the six months before the announcement is 0.67), and we use an instrumental variable approach in Section 4.3 to show that the results are not driven by banks' anticipation of the PSPP announcement or the change in the

macroprudential regime. We also note that the results are not driven by other bank characteristics. In Section 4.4, we show that the mark-to-market exposure is unrelated to some key banks' characteristics such as size, holdings of non-eligible securities, and loan-to-assets ratio. This excludes, in particular, the interpretation that only the largest banks or those more active in lending or security trading are highly exposed. While we find a link between exposure and a few other characteristics (i.e., holdings of liquid assets, capitalization, and interbank position), we show in Section 4.4 that controlling for these variables does not affect the results. We also control for banks' exposure to other policies in Section 4.5, showing that the results are again unchanged.

In sum, the PSPP elicits a lending response mainly when the eligible securities are marked to market as per capital regulation, which in 2019 occurred in the available-for-sale and trading book categories. In addition, the PSPP has no significant impact on lending among banks that are exposed to the program mainly through securities that are valued at historical cost. We next turn to the 2015 announcement, which took place under a different macroprudential regime regarding the set of securities that had to be marked-to-market.

4.2 The effects of the PSPP under the 2014-15 macroprudential regime

We now repeat the analysis of the previous section—studying the effects of the PSPP—by focusing on the 2015 PSPP announcement. Unlike 2019, the 2015 announcement took place under a macroprudential regime that used MMA accounting only for assets in the trading book; sovereign assets classified as available for sale—most sovereign assets at the time—were valued at HCA in 2015. This difference in the macroprudential regime between 2019 and 2015 allow us to confirm the role of macroprudential policy—and in particular, mark-to-market versus historical cost accounting—in transmitting unconventional monetary policy onto bank lending.

Before describing the results in detail, we note at the onset that the 2015 analysis is identical to the one derived using the 2019 announcement: The PSPP had an effect only through banks' holdings of mark-to-market sovereign securities, and we find no effect when using a broad exposure measure that ignores the macroprudential accounting regulation in place at the time.

However, because MMA was limited to the trading book in 2015, the impact of the QE announcement on bank lending is very limited and substantially smaller than in 2019. We also perform a falsification test in which we define the 2015 exposure based on the set of securities that should have been mark-to-market according to the 2019 macroprudential accounting rules. We find no effects, further supporting our main claim about the role of macroprudential regulation in affecting the transmission of quantitative easing.

We now describe the results in detail. Column 1 of Table 4 shows the results using the measure of exposure to the PSPP that ignores the macroprudential regime: the ratio of PSPP-eligible securities to total assets. This measure is calculated as of December 2014—the month before the announcement. Similar to what we obtained for 2019, we find no evidence that broad exposure to the PSPP is associated with an increase in lending after the announcement. The point estimates are small and sometimes negative, and they show no clear differences between the pre- and post-announcement period. In the announcement month and the three following months (i.e., January-April 2015), none of the coefficients is statistically different from the July-November 2014 average.

Column 2 of Table 4 uses banks' exposure to the PSPP based only on mark-to-market eligible securities according to the 2014-2015 macroprudential accounting framework—those classified in the trading book. Along the lines of the 2019 mark-to-market results, we find that banks more exposed to the PSPP via marked-to-market securities increased lending at the intensive margin almost immediately upon the PSPP's announcement. There are also no pre-trends in the period before the PSPP announcement (average July-November 2014: 0.137, p-value: 0.479), and the January 2015 coefficient is significantly greater than the July-November 2014 average (difference: 0.306, p-value: 0.000). These results are also unchanged when we control for banks' holdings of eligible securities valued at historical cost, as shown in column 3—both the mark-to-market and historical cost exposure measures are interacted with the time dummies centered on the PSPP announcement month (see Appendix A for the full list of coefficients). Nor do we observe any increase or reversal in loan growth at the intensive margin after January.

Column 4 of Table 4 uses an exposure dummy to deal with possible noises and outlier effects. Holdings of mark-to-market eligible securities were much smaller in 2014-15, in comparison to 2019. In particular, only 36 of the 95 banks in our 2014-15 sample have strictly positive holdings of marked-to-market securities, and the distribution is very skewed. Hence, we define the 2014-15 exposure dummy to be equal to one if a bank is in the top 15% of the distribution—this corresponds approximately to the median of the distribution of marked-to-market eligible securities relative to total assets, conditional on strictly positive holdings. Column 4 shows that our result is again robust to using the dichotomous measure of exposure. Loan growth increases by almost 1.8 percentage points for highly exposed banks in January 2015, relative to less exposed ones. And there is no evidence of any significant difference in loan growth across banks in the period before the announcement: the average of the PSPP exposure coefficients in July-November 2014 is -0.085 (p-value=0.886).

Column 5 presents a falsification test. We construct a 2015 exposure measure using the set of eligible securities that would have been mark-to-market according to the 2019 macroprudential accounting regulation—those classified as available-for-sale or in the trading book. These securities account for slightly more than 10% of assets held by Italian banks as of December 2014. In addition, this exercise addresses the concern that the PSPP might have elicited an increase in lending through its effect on banks' holdings of securities that banks can sell—those classified as available-for-sale or in the trading book—as opposed to those marked-to-market. However, the results are similar to those derived with the broad measure of exposure in column 1: There is no evidence that exposure to the PSPP via this measure significantly affects lending. Thus, this falsification test rules out the interpretation that QE affects banks through their holdings of securities that banks are allowed to sell per se and supports the recapitalization channel mechanism through the securities that are marked-to-market.

We conduct a long list of robustness checks for the 2015 event too, which we briefly recite here—see Sections 4.3-4.5 for the details. We find high persistence of the exposure measure (the autocorrelation coefficient in the six months before the announcement is 0.92), no evidence that banks anticipated the PSPP announcement using an instrumental variable approach, and no

evidence that our result are driven by seasonal effects (Section 4.3). We find no links between exposure and most banks' characteristics and our results are unchanged when controlling for the few characteristics that are related to exposure (Section 4.4). And we find no changes when we control for banks' exposure to other policies (Section 4.5). These results support our identification strategy and, in particular, rule out the possibility that only the largest Italian banks were highly exposed to the PSPP or that banks purchased eligible securities in anticipation of the PSPP.

The implied effect of the 2015 PSPP on loan supply is much smaller than in 2019. Our estimates imply an increase in lending €231 million in 2015, in contrast to €5.2 billion in 2019 computed earlier. The very small 2015 lending effect is the byproduct of the macroprudential accounting regulation, which segmented banking system exposure to the PSPP in 2015. In 2015, sovereign securities had to be marked-to-market only if held in the trading book, whereas the 2019 macroprudential regulation was much broader, requiring banks to mark-to-market available-for-sale and trading book sovereign securities. Because most banks recorded sovereign assets as available for sale, the 2019 PSPP announcement induced a much broader lending response relative to 2015, when few banks had a substantial exposure to the PSPP through their trading book sovereign securities.

4.3. Robustness analysis, part I: instrumental variables and (lack of) anticipatory bias, (lack of) seasonality effects

We now describe the first set of robustness checks. These sets of analyses deal with the possible concern related to the broad research design that we are using. In this section, we use an instrumental variable approach to rule out the possibility of anticipatory biases. Banks could have anticipated the PSPP announcement and tilted their portfolios toward eligible securities or the change in the macroprudential regime. We also control for seasonality effects by expanding each of the sample window to 4 years, resulting in 32 million firm-bank level observations for the 2019 announcement and 23 million for the 2015 announcement. Overall, we obtain very strong support for the baseline results of Section 4.1 and 4.2.

We first provide evidence that rules out anticipatory biases. The main concern is that some banks might have anticipated the announcement and increased their holdings of eligible securities in the months before the announcement. For instance, with respect to the January 2015 announcement, the speech by then ECB president Mario Draghi at Jackson Hole in August 2014 might have foreshadowed the January 2015 ECB's asset purchase announcement.

Before describing our tests, we note that the analysis of banks' balance sheet over time suggest that anticipatory biases are likely limited. As reported in Sections 4.1 and 4.2, banks' exposure to the PSPP is very persistent over time—the autocorrelation coefficient is 0.67 and 0.92 in the six months before the 2019 and 2015 announcements, respectively. Similarly, when using the dummy measures of exposure, 83% of the banks that were highly exposed six months before the 2019 announcement were still highly exposed in the month before the announcement. The figure is 71% for the 2015 announcement.

To rule out anticipatory biases, our main test uses an instrumental variable (IV) approach.[17] We restrict attention to the month immediately after the announcement—September 2019 and January 2015, respectively. Columns 1 and 4 in Table 5 repeat our baseline analysis showing that the results are very close to those of the baseline estimates of Tables 3 and 4. The IV regressions instrument banks' exposure in the month before the announcement using the same exposure measure calculated six months before (i.e., February 2019 and June 2014 for the 2019 and 2015 announcements, respectively). Columns 2-3 and 5-6 of Table 5 show that the IV approach confirms and even strengthen our results, using both the continuous and dummy measures of exposure. We emphasize that the IV regressions have very high Kleibergen-Paap F-stat (corresponding to the first-stage robust F statistic in our setting)—as high as 873.1. Thus, there is no concern about weak instruments (Andrews, Stock et al. 2019). The strength of the instrument comes from the high persistence in the exposure.[18]

[17] A second approach in Appendix C defines a bank to be exposed if it held a large amount of MMA sovereign securities both in the month before the announcement and six months before, and draws similar conclusions.

[18] The Kleibergen-Paap F-stat is somewhat low in column 6, which refers to the 2015 IV regression that uses the dummy measure of exposure. Nonetheless, we note that the Kleibergen-Paap F-stat is 873.1 when using the 2015 continuous exposure and, thus, we conclude that our IV analyses are immune to weak instruments concerns.

We then deal with possible seasonality concerns as well as the choice of counterfactual around the change in the macroprudential regime. In the case of the former, both the 2019 and 2015 announcements take place after periods of holidays in Italy—business activities typically slow down in August in relation to summer holidays, and during the holiday season at the end of December and early January. As a result, a possible concern is that our results could reflect seasonal changes in supply at particular bank-firm combinations rather than the causal effect of the PSPP. In the case of the latter concern, the results might reflect latent factors specific to the particular time period that also precipitated the PSPP or the change in the macroprudential accounting framework. Extending the time period allow us to identify the effects of these policies with respect to a different counterfactual.

To this end, we expand our sample window from one to four years. For the 2019 announcement, we extend the sample backward in time, starting in March 2016, and we end in February 2020 as in our main analysis. This expansion of the sample allows us to exclude the COVID-19 period. For the 2015 announcement, we keep the sample window centered around the announcement date, so that our sample runs from July 2012 to June 2016. Table 6 shows the results. We restrict attention to the response immediately after the PSPP, and thus we interact the September 2019 and January 2015 time dummies with their respective exposures. We again find evidence of a significant increase in lending among banks more exposed to the PSPP in September 2019 and January 2015, respectively, relative to the much larger set of counterfactual outcomes in this specification.

4.4 Robustness analysis, part II: exposure and banks' characteristics

We now study whether banks' exposure to the PSPP is linked with other banks' characteristics and control for some of these characteristics. We find a limited and weak link between PSPP exposure and other banks' characteristics for both the 2019 and 2015 episodes. We then run a set of robustness analyses to control for the characteristics that are correlated with exposure—and a few that are not—showing that our results are essentially unchanged.

Table 7 shows the results of regressing the PSPP-exposure based on mark-to-market eligible securities on several banks' characteristics. We conduct our analysis both for 2019 and 2015, and

for each episode, using both the continuous and dummy measures of exposure.

We include three sets of variables—we describe them here briefly and then provide more details about them in Appendix B. The first one is total assets (in log), to deal with the concern that only the largest banks could be the one that are more exposed to the policy. The second one is a list of standard characteristics: holdings of non-eligible securities, business loans, cash and reserves, and deposits, all measured in percent of total assets, and Tier 1 capital as a fraction of risk-weighted assets.[19] The third set includes variables that measure banks' exposure to other ECB policies: TLTRO, negative interest rates measured as the net interbank position as in (Bottero, Minoiu et al. 2020), the covered bonds and ABS purchase program, the corporate sector purchase program (CSPP), and the two-tier reserve system measured by the unused reserve allowance. The CSPP and unused reserve allowance are included only for the 2019 regressions, as these policies were not in place in 2014-15.

The results of Table 7 show a limited link between PSPP exposure and other banks' variables. For 2019, only the net interbank position is significantly correlated with both the continuous and dummy measure of exposure. A few other characteristics are also correlated to exposure, but only with one of the exposure measures (i.e., either the continuous or the dummy): cash and reserves, Tier 1 capital ratio, CSPP exposure, and unused reserve allowance. For 2015, the only significant correlations are with Tier 1 capital and the securitization dummy, but the links are weak (p-values = 0.096 and 0.098, respectively) and arise only with the dummy measure of exposure.

Despite the weak links with banks' characteristics, we repeat the baseline 2019 and 2015 analyses by controlling for all those that are correlated with exposure. The controls are included in the regressions by interacting each of them with time dummies centered around the announcement month. Tables D.1-D.3 in Appendix D provide the results, showing that our main findings are unchanged.

As an additional test, Appendix D controls for holdings of securities that are not eligible to be purchased under the PSPP program, both for 2019 and 2015. We run this test to rule out possible

[19] We obtain very similar results if we use common equity Tier 1 capital as a fraction of risk-weighted assets, rather Tier 1 capital as a fraction of risk-weighted assets.

general equilibrium effects that impact banks through their holdings of such non-eligible securities. The control is included by interacting it with time dummies centered around the announcement month. Our main results are again unchanged.

4.5 Robustness analysis, part III: exposure to other policies and falsification

In our last set of robustness tests, we control for banks' exposure to other policies in our baseline regressions—including other unconventional policies implemented by the European Central Bank—and we conduct a falsification test. All the tests confirm again the validity of our results.

Table 8a analyzes the 2019 announcement controlling for banks' exposure to the TLTRO and the asset purchase program in which the ECB purchased covered bonds and asset-backed securities. For the covered bonds and ABS purchase program, we measure exposure in two ways: by computing banks' holdings of such securities relative to total assets, and by constructing a dummy equal to one for banks that are involved in securitization; see Appendix B for a detailed description of these variables. All the controls are included in the regressions by interacting them with time dummies centered around the announcement month. Our results are unchanged.

We note that we have already controlled for the other unconventional monetary policies in place in 2019—negative interest rates, CSPP, and two-tier reserve system—when studying the link between banks' exposure and banks' characteristics in Section 4.4 and Appendix D (see Tables D.1 and D.2 in Appendix D).

Tables 8b and 8c focus on the 2015 announcement and control for policies in place at that time, using the continuous and dummy PSPP exposure measures, respectively. Specifically, we control for banks' exposure to the TLTRO, negative interest rates (measured again as the net interbank position), and the covered bonds and ABS purchase program; see Appendix B for a detailed description of these variables. For the covered bonds and ABS purchase program, the tables report only the regression in which we control for banks' holdings of covered bonds and ABS because we have already controlled for securitization activity in Section 4.4 and Appendix D; see Table

D.3 in Appendix D. We also control for other regulatory policies in place at the time—the comprehensive assessments that were conducted in 2013-14 (i.e., stress tests and asset quality reviews) and the regulation requiring Italian banks' supervisors to appoint the top management in certain cases. Exposure to these two policies is constructed with a dummy equal to one for banks subject to them. As with all other robustness checks, our main results are essentially unchanged.

Finally, Table 9 conducts a falsification test. We repeat our main analysis one year before the first PSPP announcement, that is, we compute the marked-to-market exposure as of December 2013 and we use the firm-bank lending relationships between July 2013 and June 2014—recall that the first PSPP announcement is in January 2015. Column 1 uses the continuous measure of exposure, and column 2 uses a dummy defined along the lines of the 2015 analysis.[20] With the continuous measure of exposure—column 1—we find no statistically significant effects. With the dummy—column 2—some coefficients are significant, but with inconsistent signs (i.e., some positive and some negative) and with a pre-trend in July-November 2013. Furthermore, the January 2014 coefficient is not statistically different from the July-November 2013 average (difference = -0.858, p-value: 0.250). Thus, this falsification test shows that holdings of marked-to-market PSPP-eligible securities one year before the first PSPP announcement do not affect lending.

5. Mechanism

The previous section suggests that banks with more holdings of PSPP-eligible securities that are mark-to-market increase loan supply immediately after the PSPP announcement, both in 2019 and 2015. This result is consistent with the hypothesized recapitalization channel of monetary policy. It implies that banks' regulatory constraints were binding before the announcement, so that the increase in the market value of PSPP-eligible securities ((Andrade, Breckenfelder et al. 2016); (Altavilla, Carboni et al. 2021)) relaxed banks' regulatory constraints, but only through holdings

[20] We construct the dummy along the lines of the 2015 baseline analysis (i.e., equal to one for the banks in the top 15% of the exposure distribution) because the macroprudential regulatory framework in the time window of the falsification test was the same as in 2015.

of securities that were evaluated using market prices. We now provide further evidence that the PSPP affected banks' behavior by relaxing their regulatory constraints (Section 5.1) and that more exposed banks sold eligible securities after the central bank began its purchases (Section 5.2).

5.1 Recapitalization channel and binding regulatory constraints

If banks' regulatory constraints were binding at the time of the PSPP announcements, we should observe a bigger effect of the PSPP on bank lending on more capital constrained banks. We show this is indeed the case both in 2019 and 2015.

We proceed by interacting banks' exposure to the PSPP with pre-announcement measures of capitalization. We also control for another related channel through which QE can transmit its effects, namely, the enhanced liquidity of the eligible securities. Central bank purchases can allow banks to liquidate eligible assets to meet loan demand without the risk of fire sales. If the liquidity channel is present, it should elicit the largest lending response among the most illiquid banks. We control for the liquidity channel by (i) interacting banks' exposure with a measure of their own pre-announcement liquidity and (ii) including an additional interaction of exposure with both capital and liquidity, as both theoretical and empirical considerations suggest that banks' lending decisions might depend not just on capitalization and liquidity positions alone but also on their interplay. For instance, a recapitalization through higher price of eligible securities might be more effective at increasing loan supply for more liquid banks.

We restrict attention to the effects of the policy in the month immediately after the announcement—September 2019 and January 2015, respectively. We center the values of capital and liquidity at the 25th percentile of their respective distributions, so that the results can be interpreted as the marginal effects for a bank that has low levels of both capital and liquidity.

Table 10 presents the results.[21] Columns 1 and 3 use Tier 1 capital as a share of risk-weighted

[21] We run the mechanism tests using only the continuous measure of exposure. The main issue with using the dummy measures of exposure is that, in 2015, only 14 banks are defined as highly exposed (i.e., their exposure dummy is equal to one), as noted in see Section 4.2. As a result, it is nearly impossible to find enough variation in capital and liquidity holdings within such a limited set of banks—this variation would be needed to identify the coefficient on the

assets as the measure of capitalization, and central bank reserves as a fraction of total assets as a measure of liquidity.[22] The impact of the PSPP is significantly lower for more capitalized banks, both in 2019 and 2015, but we detect no effects related to banks' holdings of liquidity—neither directly nor in relation to the capital position. To give some magnitudes, a one percentage point increase in the capital ratio lowers the impact of the PSPP on loan supply by about 4% in 2019 and 15% in 2015.[23] The effect is thus stronger in 2015, which is not surprising given that banks tended to have a worse capital position in 2015 relative to 2019 (see, for instance, the IMF country report No. 20/81), especially those in the left tail of the capital ratio distribution.

Columns 2 and 4 of Table 10 repeat the analyses using common equity tier-1 (CET1) capital as a fraction of risk-weighted assets as a measure of capitalization. The results confirm the overall pattern detected using the Tier 1 ratio. The results derived here are thus consistent with the view that banks' regulatory constraints were binding at the time of the announcements. That is, banks benefited from improvements in market conditions triggered by the PSPP announcements through holdings of securities that are marked-to-market, which increased the level of their regulatory capital and relaxed their capital requirement constraints.

5.2 Trading activity

We now analyze banks' trading activity. The portfolio rebalancing channel observes that banks that were more exposed to the PSPP are more likely to sell more PSPP-eligible securities than less exposed banks in order to rebalance their assets and make new loans. We show this is the case, especially for the 2019 announcement. We follow (Peydró, Polo et al. 2021) and define the unit of observation to be the trading activity of security *s* of bank *b* at time *t*—a security is defined at the

exposure dummy interacted with the capital and liquidity measures. In contrast, with the continuous exposure, we are using cross-sectional variations in capital and liquidity holdings among all the banks in our sample (i.e., approximately 90 banks both in 2015 and 2019). We also note that the 2019 results are robust to using the dummy measure of exposure, which classifies about 30 banks as highly exposed and, thus, does not suffer from the same problem we face in 2015. The results are reported in Appendix E.

[22] Results are nearly identical if we define liquidity as central bank reserves plus cash.

[23] The 2019 figure is computed as the value of the coefficient [2019m9] × QE_b ×[Tier 1 ratio]$_b$ relative to that of [2019m9] × QE_b, that is, -0.009/0.202≈4%. The 2015 figure is computed similarly.

most disaggregate level, that is, by its ISIN. We use data on the notional amount of banks' security holdings at end of each month that are (i) eligible to be purchased under the PSPP and (ii) marked-to-market, and for each bank, we compute the end-of-month quantity of each security using the corresponding end-of-period prices.[24]

We estimate a regression along the lines of our baseline specification, but we now control for security-by-time fixed effects to absorb the influence of time-varying security-level factors that affect all banks equally, in addition to bank fixed effects. The dependent variable is the trading activity of security *s* by bank *b* at time *t*, defined as

$$Trading_{s,b,t} = \frac{\left(Quantity_{s,b,t} - Quantity_{s,b,t-1}\right) \times Price_{s,t}^{average}}{(Total\ assets)_{t-1}}.$$

This variable measures the purchases—or sales, if negative—as a fraction of total assets. We note that we do not observe the actual prices at which banks trade a security, and we approximate this information with the average market price in any given month. This approximation adds noise to the dataset, and we deal with it by estimating the quarter-by-quarter effects of exposure, rather than the month-by-month ones as we do in our baseline analysis. Standard errors are clustered at the bank and ISIN level, as in (Peydró, Polo et al. 2021).

Table 11 presents the results. Columns 1 and 2 focus on the 2019 announcement using the continuous and dummy measure of exposure, and columns 3 and 4 focus on the 2015 announcement. The results suggest that more exposed banks sold more securities than less exposed ones in the last quarter of the sample, that is, after the ECB started the purchases. In 2015, the result is significant when we use the continuous measure of exposure (column 3) and not significant when we use the exposure dummy (column 4), but the point estimates in column 4 confirm the overall pattern of column 3, and the p-value of the $[2015q2] \times QE_b$ coefficient in column 4 is p=0.136.

[24] To construct the dataset, we first consider only securities that were eligible throughout our entire 12-month time window. That is, we exclude securities that are ineligible at some point within the sample window because their maturity is above or below the threshold that define the eligibility criteria (i.e., 2 and 30 years, respectively). Second, we exclude securities for which price data is not available. And third, similar to (Peydró, Polo et al. 2021), we reduce the influence of securities of small value by excluding, for each bank, securities for which the average notional amount across all periods is below €10,000. We then construct a balanced panel by assigning a zero whenever a bank does not hold a given ISIN in a given month.

To understand the magnitudes, we note that the coefficients in Table 11 represent the trading per security and per €1 million of assets of an exposed bank, relative to a less exposed one. With respect to the 2019 announcement, a back-of-the-envelope calculation based on the results of column 1 suggests that the PSPP triggered the sale of €3.8 billion in eligible securities (i.e., about 4% of the total holdings of marked-to-market eligible securities), relative to a counterfactual in which all the banks have zero exposure. For context, recall from Section 4.1 that our analysis suggests the PSPP increased bank lending by about €5.2 billion, and note that the ECB purchased about €6 billion in Italian sovereign securities in the period in which we detect significant sales by the Italian banks.[25] In 2015, because of more limited mark-to-market exposure, column 3 implies that the PSPP announcement triggered only the sale of EUR 21 million in eligible securities (i.e., about 1% of the total holdings of marked-to-market eligible securities).

Taken together, our evidence and the literature that studies the effects of the PSPP on market prices provide a consistent narrative of the transmission channel that led the PSPP announcement to increase bank lending. Prices of eligible assets increased with the announcement, especially for sovereign assets with high risk of default such as Italian debt (Altavilla, Carboni et al. 2021). Stock prices increased more for banks with more holdings of PSPP-eligible securities, independently of the accounting method used to evaluate them (Andrade, Breckenfelder et al. 2016), consistent with the notion that such prices reflect market valuations. But as banks' behavior was constrained by regulatory capital, and such capital depends on the macroprudential accounting regime, regulatory constraints were relaxed only for banks holding more mark-to-marked eligible securities, as we have shown. In turn, these banks increased lending, and more so if their regulatory constraints were tightly binding to start with.

Adding to this narrative, as the ECB started the purchases—a few months after the announcement—banks with higher mark-to-market exposure sold more securities, limiting the negative impact of possible subsequent reversion in bond prices. In this respect, banks' expectations that securities could be easily sold to the ECB to remove price risk from their own balance sheets might have played a role in shaping the lending response to the PSPP

[25] We compute the €6 billion figure using the total monthly purchase of the ECB and the fact that purchases are divided based on each country's ECB capital key—for Italy, the capital key is 13.8%.

announcements. In contrast, the lack of anticipatory effects on bank lending (Section 4.3) and of pre-trends in the analysis of banks' trading activity (this section) offer a possible explanation as to why other changes in market prices—possibly driven by signals that the ECB might have sent prior to the formal announcement—did not persuade banks to increase lending. That is, these events were not associated with a clear timeline and commitment by the ECB about actual purchases, leaving banks uncertain about their ability to sell a large amount of securities to remove price risk from their balance sheet.

6. Extension: interest rates, new lending relationships, and substitution

This section extends our previous analysis to further support our main findings. First, we document that the PSPP not only increased the quantity of bank lending but also reduced the interest rates on new term loans (Section 6.1). We then turn to the extensive margin (i.e., new lending relationships), and provide evidence that banks more exposed to the PSPP started more new lending relationships (Section 6.2). We finally aggregate the analysis up to the province-level to study substitution and competition effects between exposed and non-exposed banks (Section 6.3).

6.1 Effects on interest rates

If the PSPP caused an expansion of credit supply, the price of credit—the interest rate on loans—should decline. In contrast, if our results reflect a coincidental increase in latent credit demand, then interest rates should be non-decreasing in exposure to the PSPP after the program's implementation. This section provides evidence supporting an expansion of credit supply.

We use data on the interest rate on term loan originations with maturity greater than one year. These data are available only for a subset of banks—our final sample includes 43 banks in 2019 and 37 in 2015—and for firms with an overall outstanding loan balance at any given bank of at

least €25,000 in 2019 and €75,000 in 2015.[26] The 2019 data are available at monthly frequency, but the 2015 data are available only at quarterly frequency.[27] Appendix F shows that our main intensive margin result presented in Tables 3 and 4 holds for the subsample of banks for which we have interest rate data.

We use a modified version of the baseline specification described in Equation (1). The new dependent variable is the interest rate $i_{b,f,t}$ on a term loan originated at time t by bank b and extended to firm f.[28] Because of the limited sample, we focus on the dummy measures of exposure to the PSPP to limit the effects of noise and outliers. Table 12 presents the results. As in our baseline regressions, we use firm-by-time fixed effects to control for time-varying firm characteristics. We find that more exposed banks reduced the interest rate in comparison to less exposed ones after the announcement, and there are no pre-trends. The result is statistically significant. The magnitude is economically important with more exposed banks reducing interest rates by about 90 and 150 basis points in 2019 and 2015, respectively.

These results suggest that the PSPP announcement generated a shift of the loan supply curve—consistent with an increase in quantities and a reduction in prices. And as with all our analyses, the results hold both for 2019 and 2015.

6.2 New lending relationships: extensive margin

In addition to increasing loan supply to existing customers, banks with larger holdings of mark-to-market PSPP-eligible securities might also form new credit relationships (i.e., extensive margin). This section provides evidence of this effect. When a firm applies for a new loan from a

[26] The large majority of the new term loans in our estimation sample are on the intensive margin, that is, are extended by banks to firms that were already pre-existing customers. The sample includes a small number of observations that refer to new lending relationships, but they represent only 0.21% of the sample in 2019 and 0.17% in 2015.
[27] The Bank of Italy changed the interest rate data collection process between 2015 and 2019. To make comparisons between the data collected after the changes with those collected earlier, the Bank of Italy has developed a series of filters that can be applied to the more recent data. The filters—which we apply to construct our final dataset—require to exclude, from the 2019 data: (i) loans classified as overdrafts, credit card debt, and other revolving credit; (ii) loans related to trade receivables; (iii) loans awarded for the specific purpose of financing import and export activities.
[28] The interest rate for newly originated term loans that we use is an APR that accounts for origination fees which is referred to as *Tasso Annuo Effettivo Globale* (*TAEG*) as defined by EU Council Directive 87/102/EEC.

bank, Italian banks may use the Bank of Italy's credit register to learn about the firm's credit history. When the credit register is accessed, the request is recorded in the initial information service (IIS) dataset and helps us measure loan demand at the firm level. We can then combine the IIS dataset with the credit register data to determine whether loan demand is met at the extensive margin (Jiménez, Ongena et al. 2012).

All loan applications are classified as either successful (i.e., a new loan was disbursed over the next three months in response to the application) or unsuccessful (i.e., a lending relationship did not begin). Note that this dataset does not include new loans to existing customers—those are recorded as intensive margin responses—as applications for such loans are typically not recorded in the IIS dataset. That is, successful loan applications are cases where a bank lends to a particular borrower for the first time, forming a new credit relationship.

We use a linear probability model along the lines of equation (1), with a few changes to adapt it to structure of the loan application data. First, our dependent variable equals 1 if a firm's loan application to a bank in a specific month is successful, thereby resulting in a new loan over the next three months, and 0 otherwise—there can be a lag between the loan application and the time the loan is granted and disbursed. This is the same approach used by (Jiménez, Ongena et al. 2012). Second, motivated by the same lag, we interact our exposure measure with quarterly time dummies centered around the announcement month—as opposed to monthly dummies as in our baseline analysis. In particular, the 2019 dummies are constructed so that we can measure the effect of the announcement on exposed banks in the months of September, October, and November of that year (i.e., the three months immediately after the announcement) as well as December 2019, January 2020, and February 2020 (i.e., the following three months). Third, we continue to use bank fixed effects in the regressions, but because loan application data can be noisy, we use firm and time fixed effects separately.[29] Using firm-by-time fixed effects here would force us to focus only firms that apply to at least two banks in any given month, reducing the sample size dramatically and

[29] The noise could arise from difference sources. For instance, a bank might not access the credit register when it receives an application if it has other information about the firm, so that not all the applications are recorded in the IIS. When this is the case, we can nonetheless detect when a loan application is successful (i.e., we observe a new lending relationship in the credit register), but we do not observe if it is rejected.

limiting our ability to make inference. To further reduce noise and outlier effects, we focus on the dummy measure of exposure to the PSPP.

Table 13 presents the results. Both in 2019 and 2015, we observe a significant increase in the probability that a loan application is accepted at exposed banks, relative to less exposed ones. More precisely, in the three months after the announcements, these probabilities increase by 2.7 and 4.1 percentage points in 2019 and 2015, respectively. For reference, the unconditional probabilities that an application made in the six months before the 2019 and 2015 PSPP announcements to an exposed bank leads to a new credit relationship are 15.2% and 15.7%, respectively. In month four to six after the PSPP announcements, the point estimates suggest that the acceptance probability is still higher at more exposed banks, but the result is less precisely estimated—the p-values are 0.145 and 0.072 for 2019 and 2015, respectively.

To sum up, our analysis suggests that banks with more holdings of mark-to-market eligible securities increase lending not just to existing clients, as shown in Section 4, but also to new clients.

6.3 More lending or substitution? Province-level evidence

The evidence presented so far shows that the macroprudential accounting regime have first-order effects on the transmission of QE onto bank lending. In particular, banks that are more exposed to QE via their holdings of marked-to-market sovereign securities increased their loan supply *in comparison to less exposed banks.*

Our previous analysis, however, does not tell us whether firms experience a net increase in lending, or if they simply replace loans from non-exposed banks with loans from exposed banks. Distinguishing between these two scenarios is important to understand the broad effects of QE and macroprudential regulation and to draw adequate policy implications. If firms experience a net increase in lending, the PSPP and its transmission mediated through macroprudential regulation have a positive impact on firms, as measured by the bank lending channel. But if there is simply a *substitution* from less-exposed to more-exposed banks, the aggregate supply of credit in the local economy might be unchanged, and the policy might have no real effects. In the second case, the

macroprudential accounting regulation would produce only an effect on banks' competitive position. However, we find that this is not the case and, thus, the macroprudential regulation is likely to impact the transmission of QE to total lending.

To rule out substitution effects, we focus on how the PSPP affected lending in local banking markets. We use provinces as the relevant geographic area—the vast majority of Italian firms form credit relationships with bank branches co-located within the province.[30] There were 107 provinces in Italy in 2019.[31]

To explain our approach, consider a bank that has branches in two provinces, A and B. Suppose further that the market share of PSPP-exposed banks in province A is higher than in province B. This means that for the same bank, its branches in province A will face more competition from PSPP-exposed banks relative to its branches in province B. If substitution features in the data, loan growth at branches in province A should become slower relative to province B on account of the greater competition in province A when the ECB announces the PSPP. Note that because the unit of analysis is at the branch level, this research design can hold constant time-varying bank-level factors.

More precisely, let C_p denote the market share of PSPP-exposed banks in province p, where by "exposed" we mean a bank with exposure dummy equal to one. We define the market share as the ratio of the sum of loans to firms made by PSPP-exposed banks in province p, as a fraction of

[30] Regions or municipalities are alternative administrative areas, but we argue that using provinces produces more accurate results. In terms of regions, there are only 20 of them, and many banks operate only in a subset of such regions. As such, it might be difficult to get precise estimate at this level. Municipalities are very small in Italy. In 2013, according to Istat (Italian Statistical Institute), the average area of a municipality is 37.3 km^2, and the median is 21.9 km^2. If each municipality is approximately a circle, that means that the average radius of Italian municipalities is about 3.45 km, and the median is 2.64 km. In addition, looking at big municipalities does not change the above considerations. There are only 67 municipalities with an area greater than 250 km^2 (radius > 8.9 km); these large municipalities have, in total, 5.9 million inhabitants, about 9.9% of the population. Of these, 2.6 million are in Rome, by far the biggest city in Italy by both size and population. Source: Istat, "La superficie dei comuni, delle province e delle regioni italiane," *Statistiche Report*, Februray 19, 2013, https://www.istat.it/it/files/2015/04/Superfici-delle-unit%C3%A0-amministrative-Testo-integrale.pdf.

[31] The number was slightly higher at 110 in 2015 because of some administrative changes that took place between 2015 and 2019.

total loans to firms in the province in the month before PSPP was announced:

$$C_p = \frac{\sum_{b(p)}\left[L_{b(p)} \times QE_b\right]}{\sum_{b(p)} L_{b(p)}},$$

where $L_{b(p)}$ denotes the total amount of loans extended as of August 2019 or December 2014 by the branches of bank b that operate in province p, and QE_b is as before, our dummy that equals 1 for banks with high exposure to the PSPP, as described in Section 4.

Then our province-level estimating equation is

$$\Delta \log \mathrm{L_{b,p,t}} = \sum_{\tau \neq 2014\mathrm{m}12} \eta_\tau \times I_\tau \times C_p + \psi_{\mathrm{b,t}} + \psi_{\mathrm{p}} + \varepsilon_{b,p,t}.$$

The dependent variable is monthly loan growth rate by the branches of bank b in province p in month t. The main focus is on banks b that are not exposed, to check if such banks reduced lending at the expense of more exposed banks. For 2019, a bank is not exposed if it is in bottom tercile of the marked-to-market exposure distribution, and for 2015, a bank is not exposed if it is in the bottom 85% of the exposure distribution, following the exposure dummy defined in Sections 4.1 and 4.2.

The coefficient of interest is η_τ, which is interacted with monthly dummies around the PSPP window, I_τ, and the market share of PSPP-exposed banks, C_p. The sequence of coefficients η_τ measures whether loan growth at branches in the province differs in the months before and after the PSPP, depending on the market share of PSPP-exposed banks in the province. If there is substitution, then η_τ should be negative immediately after the PSPP is announced, as PSPP-exposed banks displace lending of their competitors. Standard errors are clustered at the bank and province level.

Using the suite of bank-by-time and province fixed effects, our key identification assumption is that shocks to loan growth at the bank-province level do not vary around the announcement window with the province-level PSPP market share variable and by whether a bank itself is exposed to the PSPP. Put differently, these estimates of substitution are unbiased even if there are province-specific variations in the lending supply component of a given bank, as long as such variations are not correlated with the market share of PSPP-exposed banks C_p.

Table 14a and 14b present the results for 2019 and 2015, respectively. Column 1 shows that total lending growth at branches of non-exposed banks is not affected by local the degree of exposure of local competitors in 2019. However, in 2015, we find that a reduction in lending by branches of non-exposed banks, when facing higher competition from more exposed ones. To shed light on this difference, Columns 2 and 3 analyze the effects on lending to existing and new customers (i.e., intensive and extensive margin), respectively. We now obtain similar results for 2019 and 2015. That is, when the PSPP was announced, branches of non-exposed banks contracted lending to new customers in provinces in which their local competitors are highly exposed, but we observe no effect on lending to existing customers. We complement the latter result by showing, in Appendix G, that exposed banks did not create any spillover on the lending supply of other banks at the intensive margin, following the approach of (Berg, Reisinger, et al. 2021).

To reduce the possible noise associated with the lag in new loan disbursement, column 4 of Tables 14a and 14b repeat the analysis of column 3 (i.e., the extensive margin) by interacting the province-level market share of exposed banks with quarterly dummies, rather than monthly dummies. Recall that, in Section 6.2, we consider a loan application to be approved if a new loan is disbursed up to three months after the application, following (Jiménez, Ongena et al. 2012). Column 4 of Tables 14a and 14b shows that the results are confirmed when we use the quarterly time dummies. To provide some magnitude of the effects, we note that a one percent increase in the market share of exposed banks reduces the growth rate of loans to new customers by non-exposed banks by about 9 and 3 percentage points in 2019 and 2015, in the three months after the announcement—the 2019 effect is bigger, but so are the confidence bands.

Overall, the results of this section show that no substitution occurred for existing credit relationships (i.e., at the intensive margin) but occurred for new ones (i.e., at the extensive margin). This finding reflects the fact that existing credit relationships are sticky in the short run, rendering substitution possible mainly at the extensive margin. In addition, because lending relationships are long lasting and most of the stock of banks' loans are in ongoing lending relationships, the impact of the extensive margin substitution on overall lending is very weak. Indeed, when analyzing all

loans of non-exposed banks (i.e., column 1 of Tables 14a and 14b), we are unable to detect any substitution in 2019 and, for 2015, the magnitude is very small.

7. Conclusion

This paper has used Italian credit register and granular supervisory data to study the role of macroprudential accounting regulation in affecting the transmission of asset purchase programs onto bank lending. We focused on two announcements related to the PSPP program implemented by the ECB, namely, the beginning of the program in January 2015 and the restart in 2019 after a pause of almost a year. We find an increase in the supply of bank lending triggered by the PSPP only through eligible securities that are marked-to-market for capital regulation purposes, and no response through banks' holdings of eligible securities that are valued at historical cost. Because the macroprudential accounting regulation limited the set of securities that were marked-to-market in 2015, we find an extremely small effect on bank lending at that time. In contrast, we find a much bigger response after a pause-and-restart of the PSPP in 2019, a result that we attribute to the change in macroprudential regulation that required a much bigger fraction of eligible securities to be valued based on mark-to-market accounting.

This paper opens up several directions for future research. Notably, theories that study the tradeoff between historical cost and mark-to-marked accounting in propagating financial system shocks might also incorporate how this choice of accounting system can influence the efficacy of central bank stabilization policies. In addition, our estimates can help inform parameter choices in quantitative models that study the monetary transmission mechanism. Finally, our results suggest that macroprudential tools other than those based on historical cost accounting, such as time-varying capital requirements might be better candidates at limiting fire sales and preventing credit crunches without impairing the transmission of unconventional monetary policy.

Table 1: Summary statistics, firm-bank lending relationships

Panel A: Number of lending relationships

	August 2019		December 2014	
	N	Percent	N	Percent
2	177,719	60	141,323	65
3	62,810	21	44,983	21
4	26,928	9	17,089	8
5	13,101	4	7,330	3
6+	17,331	6	5,993	3
Total	297,889	100	216,718	100

Panel B: Firm-bank lending relationships, 2019-2020

Firm-bank lending relationships	N	Mean	1st quartile	Median	3rd quartile	Std. dev.
All firms						
Amount borrowed, EUR (as of August 2019)	1,627,719	369,160	32,471	71,812	192,847	5,243,616
Log change amount borrowed, % (12-month window)	17,117,125	-0.55	-3.34	-0.33	0.38	50.57
Firms with more than one bank relationship in each month						
Amount borrowed, EUR (as of August 2019)	846,248	533,040	33,068	93,101	287,706	6,942,672
Log change amount borrowed, % (12-month window)	8,780,431	-0.77	-5.72	-0.32	1.99	57.20

Panel C: Firm-bank lending relationships, 2014-15

Firm-bank lending relationships	N	Mean	1st quartile	Median	3rd quartile	Std. dev.
All firms						
Amount borrowed, EUR (as of December 2014)	1,216,779	414,973	36,370	79,218	211,910	5,444,324
Log change amount borrowed, % (12-month window)	13,186,871	0.17	-2.04	0.00	0.61	46.33
Firms with more than one bank relationship in each month						
Amount borrowed, EUR (as of December 2014)	563,922	625,108	43,978	115,779	346,191	7,587,313
Log change amount borrowed, % (12-month window)	6,117,128	0.19	-2.97	0.00	1.24	51.16

Panel D: Interest rates on new term loans, 2019-20

Interest rates on new term loans	N	Mean	1st quartile	Median	3rd quartile	Std. dev.
All observations						
Interest rate, %	248,439	4.18	2.44	3.80	5.52	2.35
Firms with new term loans from multiple banks in each month						
Interest rate, %	14,574	3.17	1.63	2.67	4.18	2.10

Panel E: Interest rates on new term loans, 2014-15

Interest rates on new term loans	N	Mean	1st quartile	Median	3rd quartile	Std. dev.
All observations						
Interest rate, %	127,369	4.82	3.07	4.39	6.13	2.46
Firms with new term loans from multiple banks in each quarter						
Interest rate, %	9,451	3.97	2.39	3.54	5.03	2.19

Panel F: Loan applications and initial information service (IIS), 2019-20

March 2019 to February 2020	
Number of requests	828,470
Number of unique firms	550,259
Number of firms that submit at least 2 applications in a month	16,963

Panel G: Loan applications and initial information service (IIS), 2014-15

July 2014 to June 2015	
Number of requests	662,904
Number of unique firms	440,892
Number of firms that submit at least 2 applications in a month	11,972

Panel A displays the distribution of the number of lending relationships for the firms with outstanding loans reported in Italian credit register. Panels B and C display the distribution of the amount borrowed (in August 2019 and December 2014, respectively) and the log change in the amount borrowed (for each month in the sample, that is, March 2019 – February 2020, and July 2014 – June 2015, respectively). Panel D and E display the interest rates distribution for new terms loans. Panel F and G display key summary statistics about loan applications from the initial information service (IIS).

Table 2: Bank-level summary statistics

		Mean	1st quartile	Median	3rd quartile	Std Dev	Coeff Var
Eligible securities, % of assets	Aug 2019	17.06	7.14	15.14	24.42	13.39	0.79
	Dec 2014	11.44	1.69	8.10	18.37	11.35	0.99
Eligible securities, marked-to-market, % of assets	Aug 2019	6.00	0.18	3.16	6.66	9.74	1.62
	Dec 2014	0.45	0.00	0.00	0.001	1.63	3.65
Eligible securities, historical cost, % assets	Aug 2019	11.12	3.09	7.68	18.18	10.41	0.94
	Dec 2014	11.00	1.33	8.10	17.46	11.18	1.02
Eligible securities, available for sale and trading book, % of assets	Aug 2019	6.00	0.18	3.16	6.66	9.74	1.62
	Dec 2014	10.43	0.17	6.69	17.65	11.02	1.06
Non-eligible securities, available for sale, % of assets	Aug 2019	3.65	0.29	1.36	4.69	5.57	1.53
	Dec 2014	9.01	1.47	5.66	12.68	10.6	1.18
Non-eligible securities, trading book, % of assets	Aug 2019	4.81	0.15	2.24	6.59	7.11	1.48
	Dec 2014	4.12	0.00	0.19	6.30	6.46	1.56
Log of total assets	Aug 2019	21.85	20.25	21.53	23.39	2.16	0.10
	Dec 2014	21.38	19.41	21.45	22.82	2.20	0.10
Business loans, % of assets	Aug 2019	25.59	7.88	22.46	32.09	38.6	1.51
	Dec 2014	25.07	10.85	26.66	37.21	15.5	0.62
Liquidity (i.e., cash and reserves), % of assets	Aug 2019	3.25	0.27	1.19	3.11	6.67	2.05
	Dec 2014	1.31	0.08	0.76	1.29	1.81	1.39
Tier 1 capital, % of risk-weighted assets	Jun 2019	19.14	12.74	15.17	19.05	12.58	0.66
	Dec 2014	22.10	10.90	14.18	26.00	24.56	1.11
CET1 capital, % of risk-weighted assets	Jun 2019	18.89	12.38	14.88	19.00	12.66	0.67
	Dec 2014	21.98	10.63	13.83	26.00	24.61	1.12
TLTRO, % of total assets	Feb 2019	9.52	5.82	9.98	12.6	5.17	0.54
	Dec 2014	0.33	0.00	0.00	1.00	2.20	6.65
Net interbank position, % of assets	Jun 2019	4.08	-0.64	0.57	4.29	11.20	2.75
	Mar 2014	-0.35	-3.73	0.00	2.97	12.30	-35.64
Securitization dummy	Aug 2019	0.46	0	0	1	0.50	1.10
	Aug 2014	0.28	0	0	1	0.45	1.60
Covered bonds and ABS, available for sale and trading book, % of assets	Aug 2019	1.64	0.00	0.00	1.33	3.58	2.19
	Aug 2014	1.68	0.00	0.00	1.53	3.51	2.09
CSPP-eligible securities, available for sale and trading book, % of assets	Aug 2019	0.07	0.00	0.00	0.03	0.19	2.57
Unused allowance, two-tier reserve system, % of assets	Jun-Sept 2019	1.13	0.00	0.00	0.91	3.51	3.11
Log change of borrowing from the ECB, %	Mar 2019-Feb 2020	-2.3	0.00	0.00	0.00	142	-61.66
	Jul 2014-Jun 2015	-12.2	0.00	0.00	0.00	270	-22.12

The table displays key summary statistics for the banks in our sample. We have 95 banks in 2014, and 90 in 2019. See Appendix B for the definition of TLTRO, net interbank position, securitization dummy, and unused allowance.

Table 3: 2019 PSPP announcement

	(1)	(2)	(3)	(4)
[2019m3]× QE_b	-0.006	0.021	0.025	0.846
	[0.019]	[0.081]	[0.083]	[0.967]
[2019m4] × QE_b	0.172***	0.176	0.104	0.081
	[0.043]	[0.161]	[0.139]	[1.869]
[2019m5] × QE_b	0.057**	0.099	0.079	0.895
	[0.025]	[0.065]	[0.058]	[0.727]
[2019m6] × QE_b	0.010	0.051	0.050	1.394
	[0.021]	[0.114]	[0.125]	[1.524]
[2019m7] × QE_b	0.115***	0.071	0.017	0.145
	[0.030]	[0.137]	[0.129]	[1.766]
[2019m9] × QE_b	0.105**	0.248**	0.216**	2.663**
	[0.041]	[0.108]	[0.094]	[1.053]
[2019m10] × QE_b	0.038	-0.185	-0.223	0.586
	[0.049]	[0.224]	[0.238]	[1.078]
[2019m11] × QE_b	-0.017	0.097	0.109	1.875
	[0.029]	[0.105]	[0.112]	[1.473]
[2019m12] × QE_b	0.102***	0.350***	0.320***	3.415***
	[0.035]	[0.095]	[0.090]	[0.711]
[2020m1] × QE_b	0.121***	0.107	0.062	-0.276
	[0.033]	[0.142]	[0.128]	[1.825]
[2020m2] × QE_b	-0.025*	0.020	0.028	-0.209
	[0.014]	[0.048]	[0.049]	[0.367]
QE_b exposure measure	All eligible securities	Eligible securities marked-to-market (= available for sale and trading book)	Eligible securities marked-to-market (= available for sale and trading book)	Eligible securities marked-to-market, dummy (= available for sale and trading book)
Bank FEs	Yes	Yes	Yes	Yes
Firm-time FEs	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes
ECB lending	Yes	Yes	Yes	Yes
HCA exposure	No	No	Yes	No
Observations	8,346,934	8,346,934	8,346,934	8,346,934
R-squared	0.369	0.369	0.370	0.370

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. The variable QE_b is computed as of August 2014 and normalized by total assets in columns 1-3. In column 4, QE_b is a dummy equal to one for banks in the top tercile of the distribution of marked-to-market eligible securities relative to total assets, and results are reported relative to banks in the bottom tercile. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: 2015 PSPP announcement

	(1)	(2)	(3)	(4)	(5)
[2014m7]× QE_b	-0.048	0.080	0.112	0.367	-0.034
	[0.040]	[0.132]	[0.131]	[0.630]	[0.041]
[2014m8] × QE_b	-0.152***	0.188	0.291	0.452	-0.155**
	[0.054]	[0.171]	[0.188]	[0.611]	[0.066]
[2014m9] × QE_b	-0.003	0.277	0.286	0.834	0.022
	[0.055]	[0.234]	[0.228]	[0.580]	[0.052]
[2014m10] × QE_b	-0.085	-0.099	-0.046	-0.889	-0.057
	[0.053]	[0.234]	[0.240]	[0.909]	[0.059]
[2014m11] × QE_b	-0.006	0.238	0.249	-0.342	-0.026
	[0.062]	[0.274]	[0.267]	[0.915]	[0.072]
[2015m1] × QE_b	-0.076	0.443**	0.503***	1.784**	-0.016
	[0.053]	[0.174]	[0.186]	[0.725]	[0.054]
[2015m2] × QE_b	-0.075*	0.144	0.196	0.040	-0.080*
	[0.038]	[0.180]	[0.187]	[0.682]	[0.045]
[2015m3] × QE_b	0.014	0.068	0.063	0.402	-0.014
	[0.055]	[0.160]	[0.151]	[0.553]	[0.052]
[2015m4] × QE_b	-0.080*	0.090	0.144	0.044	-0.061
	[0.043]	[0.164]	[0.172]	[0.558]	[0.047]
[2015m5] × QE_b	-0.114**	0.048	0.122	-0.532	-0.130**
	[0.050]	[0.183]	[0.186]	[0.734]	[0.057]
[2015m6] × QE_b	0.012	0.065	0.061	0.238	-0.003
	[0.054]	[0.126]	[0.114]	[0.502]	[0.049]
QE_b exposure measure	All eligible securities	Eligible securities marked-to-market (=trading book)	Eligible securities marked-to-market (=trading book)	Eligible securities marked-to-market, dummy (=trading book)	Available-for-sale and trading book eligible securities (i.e., falsification)
Observations	5,867,308	5,867,308	5,867,308	5,867,308	5,867,308
R-squared	0.394	0.394	0.394	0.394	0.394
Bank FEs	Yes	Yes	Yes	Yes	Yes
Firm-time FEs	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
ECB lending	Yes	Yes	Yes	Yes	Yes
HCA exposure	No	No	Yes	No	No

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. The variable QE_b is computed as of December 2014 and is normalized by total assets in column 1-3 and 5. In column 4, QE_b is a dummy equal to one for banks in the top 15% of the distribution of marked-to-market eligible securities relative to total assets. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: (Lack of) anticipatory bias, instrumental variable approach

	2019 announcement				2015 announcement		
	(1)	(2)	(3)		(4)	(5)	(6)
	Baseline	IV	IV, dummy exposure		Baseline	IV	IV, dummy exposure
$[2019m9] \times QE_b$	0.176**	0.214**	2.383***	$[2015m1] \times QE_b$	0.343***	0.417***	7.82**
	[0.070]	[0.085]	[0.615]		[0.054]	[0.080]	[3.764]
Instrument	-	February 2019 exposure	February 2019 exposure		-	June 2014 exposure	June 2014 exposure
Bank FEs	Yes	Yes	Yes		Yes	Yes	Yes
Firm-time FEs	Yes	Yes	Yes		Yes	Yes	Yes
Size	Yes	Yes	Yes		Yes	Yes	Yes
ECB lending	Yes	Yes	Yes		Yes	Yes	Yes
Observations	8,346,934	8,346,934	8,346,934		5,867,308	5,867,308	5,867,308
Kleibergen-Paap F-stat	-	232.8	18.4		-	873.1	3.0

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. In columns 1 and 4, the PSPP exposure measure QE_b is computed at the end of the month before the announcement (i.e., August 2019 for the 2019 announcement and December 2014 for the 2015 announcement, respectively). In columns 2, 3, 5, and 6, the PSPP exposure measure QE_b is computed as of the month before the announcement (i.e., August 2019 for the 2019 announcement and December 2014 for the 2015 announcement, respectively) and instrumented using its value six months before (i.e., February 2019 and June 2014 for the 2019 and 2015 announcement, respectively). In columns 1, 2, 4, and 5, the variable QE_b is computed as the value of marked-to-market PSPP-eligible securities relative to total assets. In column 3, the variable QE_b is a dummy equal to one for banks in the top tercile of the distribution of marked-to-market PSPP-eligible securities relative to total assets, and results are reported relative to banks in the bottom tercile. In column 6, the variable QE_b is a dummy equal to one for banks in the top 15% of the distribution of marked-to-market PSPP-eligible securities relative to total assets. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Extending the counterfactual

2019 announcement			2015 announcement		
	(1)	(2)		(3)	(4)
[2019m9] × QE_b	0.145** [0.057]	1.685*** [0.552]	[2015m1] × QE_b	0.279** [0.112]	1.347*** [0.406]
QE_b exposure measure	Continuous	Dummy		Continuous	Dummy
Time window	March 2016 – February 2020	March 2016 – February 2020		July 2012 – June 2016	July 2012 – June 2016
[Monthly dummies] × QE_b	Yes	Yes		Yes	Yes
Bank FEs	Yes	Yes		Yes	Yes
Firm-time FEs	Yes	Yes		Yes	Yes
Size	Yes	Yes		Yes	Yes
ECB lending	Yes	Yes		Yes	Yes
Observations	32,883,854	32,883,854		23,396,405	23,396,405
R-squared	0.370	0.370		0.398	0.398

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. In columns 1 and 3, the variable QE_b is computed as the value of marked-to-market PSPP-eligible securities relative to total assets as of August 2019 and December 2014, respectively. In column 2, the variable QE_b is a dummy equal to one for banks in the top tercile of the distribution of marked-to-market PSPP-eligible securities relative to total assets as of August 2019, and results are reported relative to banks in the bottom tercile. In column 4, the variable QE_b is a dummy equal to one for banks in the top 15% of the distribution of marked-to-market PSPP-eligible securities relative to total assets as of December 2014. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Banks' exposure and other bank characteristics

	(1)	(2)	(3)	(4)
	2019 MMA exposure	2019 MMA exposure, dummy	2015 MMA exposure	2015 MMA exposure, dummy
Log of total assets	-0.386	-0.040	-0.015	-0.019
	[0.724]	[0.029]	[0.087]	[0.019]
Non-eligible securities, available for sale and trading book, % of total assets	-0.065	0.005	-0.008	-0.001
	[0.147]	[0.007]	[0.010]	[0.003]
Business loans, % of total assets	-0.008	0.000	-0.002	-0.001
	[0.018]	[0.001]	[0.008]	[0.002]
Cash and reserves, % of total assets	-0.206**	-0.008	-0.085	0.012
	[0.091]	[0.005]	[0.081]	[0.023]
Deposits, % of total assets	0.106	0.001	0.012	0.001
	[0.067]	[0.002]	[0.013]	[0.002]
Tier 1 capital, % of risk-weighted assets	0.286**	0.005	-0.003	-0.002*
	[0.138]	[0.004]	[0.004]	[0.001]
TLTRO exposure, % of total assets	-0.077	0.006	0.063	0.001
	[0.256]	[0.012]	[0.077]	[0.014]
Net interbank position, % of total assets	-0.190**	-0.008**	0.007	0.000
	[0.076]	[0.004]	[0.011]	[0.003]
Securitization dummy	-2.219	-0.147	-0.479	-0.131*
	[3.065]	[0.164]	[0.355]	[0.078]
Covered bonds and ABS, available for sale and trading book, % of total assets	0.136	-0.007	-0.001	-0.006
	[0.286]	[0.017]	[0.017]	[0.009]
CSPP exposure, % of assets	-3.496	0.416*		
	[5.416]	[0.231]		
Unused reserve allowance, % of assets	0.023	0.024***		
	[0.136]	[0.009]		
Observations	89	89	93	93
R-squared	0.283	0.282	0.077	0.066

The dependent variable is the bank-level PSPP exposure measure based on marked-to-market PSPP-eligible securities calculated as of August 2019 (for the September 2019 announcement) and December 2014 (for the January 2015 announcement). The 2019 dummy is equal to one for banks in the top tercile of the distribution of marked-to-market eligible securities over assets, and the 2015 dummy is equal to one for banks in the top 15% of the distribution of marked-to-market eligible securities over assets. See Appendix B for the definition of TLTRO exposure, securitization dummy (see "Exposure to covered bonds and asset-backed securities purchase program"), CSPP exposure, and unused reserve allowance. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 8a: Banks' exposure to other ECB policies, 2019 announcement

	(1)	(2)	(3)	(4)	(5)	(6)
[2019m3]× QE_b	0.021	0.022	0.019	0.865	0.868	0.859
	[0.081]	[0.085]	[0.082]	[0.984]	[1.006]	[0.969]
[2019m4] × QE_b	0.195	0.184	0.182	0.307	0.074	0.080
	[0.162]	[0.172]	[0.170]	[1.897]	[1.895]	[1.858]
[2019m5] × QE_b	0.102	0.097	0.101	0.917	0.861	0.907
	[0.067]	[0.071]	[0.069]	[0.725]	[0.752]	[0.733]
[2019m6] × QE_b	0.055	0.053	0.073	1.524	1.436	1.338
	[0.113]	[0.119]	[0.121]	[1.540]	[1.570]	[1.509]
[2019m7] × QE_b	0.072	0.047	0.064	0.068	-0.089	0.173
	[0.137]	[0.143]	[0.145]	[1.787]	[1.710]	[1.758]
[2019m9] × QE_b	0.244**	0.253**	0.257**	2.572**	2.682**	2.679**
	[0.108]	[0.116]	[0.109]	[1.062]	[1.104]	[1.066]
[2019m10] × QE_b	-0.134	-0.208	-0.150	1.623	0.516	0.658
	[0.192]	[0.237]	[0.212]	[0.980]	[1.076]	[1.015]
[2019m11] × QE_b	0.086	0.087	0.106	1.721	1.822	1.878
	[0.102]	[0.108]	[0.124]	[1.496]	[1.509]	[1.494]
[2019m12] × QE_b	0.332***	0.326***	0.386***	3.185***	3.250***	3.431***
	[0.093]	[0.100]	[0.092]	[0.716]	[0.666]	[0.712]
[2020m1] × QE_b	0.107	0.084	0.084	-0.430	-0.575	-0.307
	[0.138]	[0.149]	[0.156]	[1.842]	[1.808]	[1.843]
[2020m2] × QE_b	0.018	0.017	-0.004	-0.259	-0.259	-0.235
	[0.047]	[0.050]	[0.049]	[0.362]	[0.391]	[0.367]
QE_b exposure measure	Continuous	Continuous	Continuous	Dummy	Dummy	Dummy
TLTRO exposure	Yes	No	No	Yes	No	No
Covered bonds and ABS	No	Yes	No	No	Yes	No
Securitization	No	No	Yes	No	No	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes
Firm-time FEs	Yes	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes
ECB lending	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,346,934	8,346,934	8,346,934	8,346,934	8,346,934	8,346,934
R-squared	0.370	0.369	0.369	0.370	0.370	0.370

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. The variable QE_b is the exposure of bank *b* to the PSPP as of August 2019. In columns 1-3, QE_b is computed as the value of marked-to-market PSPP-eligible securities relative to total assets. In columns 4-6, QE_b is a dummy equal to one for banks in the top tercile of the distribution of marked-to-market PSPP-eligible securities relative to total assets, and results are reported relative to banks in the bottom tercile. See Appendix B for the definition of TLTRO exposure, covered bonds and ABS exposure, and securitization dummy. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 8b: Banks' exposure to other policies, 2015 announcement, continuous exposure

	(1)	(2)	(3)	(4)	(5)
[2014m7]× QE_b	0.068	0.129	0.056	0.022	0.049
	[0.126]	[0.131]	[0.146]	[0.117]	[0.130]
[2014m8] × QE_b	0.171	0.261	0.170	0.159	0.163
	[0.122]	[0.170]	[0.198]	[0.146]	[0.177]
[2014m9] × QE_b	0.255	0.291	0.341	0.274	0.313
	[0.167]	[0.223]	[0.229]	[0.232]	[0.238]
[2014m10] × QE_b	-0.120	-0.082	-0.060	-0.149	-0.145
	[0.161]	[0.222]	[0.232]	[0.208]	[0.240]
[2014m11] × QE_b	0.220	0.211	0.237	0.076	0.190
	[0.204]	[0.250]	[0.295]	[0.229]	[0.280]
[2015m1] × QE_b	0.422***	0.504***	0.446**	0.434**	0.439**
	[0.120]	[0.172]	[0.190]	[0.169]	[0.179]
[2015m2] × QE_b	0.128	0.195	0.147	0.160	0.128
	[0.132]	[0.177]	[0.192]	[0.184]	[0.183]
[2015m3] × QE_b	0.056	0.119	0.085	0.063	0.079
	[0.129]	[0.176]	[0.167]	[0.184]	[0.164]
[2015m4] × QE_b	0.076	0.135	0.115	0.087	0.070
	[0.127]	[0.160]	[0.165]	[0.155]	[0.165]
[2015m5] × QE_b	0.032	0.092	0.023	0.005	-0.005
	[0.146]	[0.176]	[0.207]	[0.164]	[0.188]
[2015m6] × QE_b	0.052	0.100	0.107	0.050	0.107
	[0.084]	[0.126]	[0.125]	[0.123]	[0.127]
TLTRO exposure	Yes	No	No	No	No
Net interbank position	No	Yes	No	No	No
Covered bonds and ABS	No	No	Yes	No	No
Comprehensive assessment	No	No	No	Yes	No
Governance rules	No	No	No	No	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes
Firm-time FEs	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
ECB lending	Yes	Yes	Yes	Yes	Yes
Observations	5,867,308	5,867,308	5,867,308	5,867,308	5,867,308
R-squared	0.394	0.394	0.394	0.394	0.394

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. The variable QE_b is the exposure of bank *b* to the PSPP as of December 2014, computed as the value of marked-to-market PSPP-eligible securities relative to total assets. See Appendix B for the definition of TLTRO exposure, net interbank position, covered bonds and ABS exposure, comprehensive assessment dummy, and governance rules dummy. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 8c: Banks' exposure to other policies, 2015 announcement, dummy exposure

	(1)	(2)	(3)	(5)	(6)
[2014m7]× QE_b	0.452	0.526	0.318	0.206	0.416
	[0.738]	[0.676]	[0.665]	[0.627]	[0.545]
[2014m8] × QE_b	0.588	0.675	0.447	0.363	0.537
	[0.745]	[0.640]	[0.676]	[0.599]	[0.590]
[2014m9] × QE_b	0.989	0.868	0.932	0.812	0.769
	[0.762]	[0.611]	[0.610]	[0.640]	[0.643]
[2014m10] × QE_b	-0.745	-0.833	-0.832	-1.026	-0.819
	[1.019]	[0.954]	[0.787]	[0.973]	[0.916]
[2014m11] × QE_b	-0.212	-0.450	-0.359	-0.801	-0.259
	[1.116]	[0.927]	[0.922]	[1.003]	[0.834]
[2015m1] × QE_b	1.919**	1.999**	1.717**	1.757**	1.747**
	[0.902]	[0.799]	[0.756]	[0.745]	[0.700]
[2015m2] × QE_b	0.153	0.198	0.034	0.078	0.064
	[0.829]	[0.717]	[0.685]	[0.720]	[0.636]
[2015m3] × QE_b	0.489	0.567	0.427	0.387	0.375
	[0.590]	[0.583]	[0.574]	[0.640]	[0.553]
[2015m4] × QE_b	0.142	0.185	0.081	0.034	0.074
	[0.660]	[0.606]	[0.536]	[0.567]	[0.526]
[2015m5] × QE_b	-0.418	-0.397	-0.593	-0.658	-0.441
	[0.898]	[0.771]	[0.771]	[0.714]	[0.609]
[2015m6] × QE_b	0.327	0.354	0.310	0.199	0.150
	[0.502]	[0.517]	[0.510]	[0.521]	[0.502]
TLTRO	Yes	No	No	No	No
Net interbank position	No	Yes	No	No	No
Covered bonds and ABS	No	No	Yes	No	No
Comprehensive assessment	No	No	No	Yes	No
Governance rules	No	No	No	No	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes
Firm-time FEs	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
ECB lending	Yes	Yes	Yes	Yes	Yes
Observations	5,867,308	5,867,308	5,867,308	5,867,308	5,867,308
R-squared	0.394	0.394	0.394	0.394	0.394

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* at time *t*. The variable QE_b is a dummy equal to one if the ratio of marked-to-market eligible securities to total assets as of December 2014 is in the top 15% of the distribution. See Appendix B for the definition of TLTRO exposure, net interbank position, covered bonds and ABS exposure, comprehensive assessment dummy, and governance rules dummy. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: Falsification tests, one year before the first PSPP announcement

	(1) Falsification, continuous exposure	(2) Falsification, dummy exposure
[2013m7] × QE_b	0.017	-0.342**
	[0.174]	[0.147]
[2013m8] × QE_b	0.115	-0.029
	[0.122]	[0.195]
[2013m9] × QE_b	0.278	0.376
	[0.188]	[0.284]
[2013m10] × QE_b	0.130	0.305***
	[0.128]	[0.106]
[2013m11] × QE_b	-0.031	0.248
	[0.217]	[0.286]
[2014m1] × QE_b	-0.267	-0.747
	[0.348]	[0.583]
[2014m2] × QE_b	0.005	0.054
	[0.146]	[0.160]
[2014m3] × QE_b	-0.190	-0.345
	[0.152]	[0.327]
[2014m4] × QE_b	-0.056	-0.308
	[0.156]	[0.186]
[2014m5] × QE_b	0.158	0.784***
	[0.264]	[0.188]
[2014m6] × QE_b	-0.215	-0.618***
	[0.201]	[0.225]
Time window	July 2013 – June 2014	July 2013 – June 2014
Exposure as of	December 2013	December 2013
Observations	5,213,795	5,213,795
R-squared	0.380	0.380
Bank FEs	Yes	Yes
Firm-time FEs	Yes	Yes
Size	Yes	Yes
ECB lending	Yes	Yes

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. The variable QE_b is the PSPP exposure (calculated as of the date indicated next to "Exposure as of") defined as the ratio of marked-to-market eligible securities to total assets as of December 2013 (column 1) or a dummy equal to one if such a ratio is in the top 15% of the distribution (column 2). Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 10: Mechanism, capital and liquidity

	2019 announcement			2015 announcement	
	(1)	(2)		(3)	(4)
$[2019m9] \times QE_b$	0.202**	0.215**	$[2015m1] \times QE_b$	0.495**	0.524**
	[0.100]	[0.104]		[0.234]	[0.243]
$[2019m9] \times QE_b \times$ [Tier 1 ratio]$_b$	-0.009**		$[2013m1] \times QE_b \times$ [Tier 1 ratio]$_b$	-0.078*	
	[0.004]			[0.041]	
$[2019m9] \times QE_b \times$ [CET1 ratio]$_b$		-0.008*	$[2015m1] \times QE_b \times$ [CET1 ratio]$_b$		-0.080**
		[0.005]			[0.042]
$[2019m9] \times QE_b$ ×[liquidity/assets]$_b$	-0.012	-0.012	$[2015m1] \times QE_b \times$ [liquidity/assets]$_b$	0.420	0.354
	[0.023]	[0.022]		[0.537]	[0.541]
$[2019m9] \times QE_b \times$ [Tier 1 ratio]$_b$×[liquidity/assets]$_b$	-0.007		$[2015m1] \times QE_b \times$ [Tier 1 ratio]$_b$×[liquidity/assets]$_b$	0.064	
	[0.009]			[0.077]	
$[2019m9] \times QE_b \times$ [CET1 ratio]$_b$×[liquidity/assets]$_b$		-0.002	$[2015m1] \times QE_b \times$ [CET1 ratio]$_b$×[liquidity/assets]$_b$		0.074
		[0.007]			[0.078]
Bank FEs	Yes	Yes		Yes	Yes
Firm-time FEs	Yes	Yes		Yes	Yes
Size	Yes	Yes		Yes	Yes
ECB lending	Yes	Yes		Yes	Yes
Observations	8,295,389	8,295,389		5,623,310	5,623,310
R-squared	0.370	0.370		0.396	0.396

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. The variable QE_b is the ratio of marked-to-market eligible securities to total assets as of August 2019 (column 1-2) or as of December 2014 (column 3-4). Tier 1 ratio is the ratio of Tier 1 capital to risk-weighted assets; CET1 ratio is the ratio of CET1 capital to risk-weighted assets; and liquidity denotes central bank reserves. The regression in column 1 includes $[2019m9] \times$[Tier 1 ratio]$_b$, $[2019m9] \times$[liquidity/assets]$_b$, and $[2019m9] \times$[Tier 1 ratio]$_b$×[liquidity/assets]$_b$, and similarly for regressions in columns 2-4. Tier 1 ratio, CET1 ratio, and liquidity/assets are normalized by their respective first quartile levels. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 11: Trading activity of banks

	2019 announcement			2015 announcement	
	(1)	(2)		(3)	(4)
[2019m3-m5] × QE_b	-0.042	-1.455	[2014q2] × QE_b	0.091	0.083
	[0.091]	[2.158]		[0.060]	[0.260]
[2019m9-m11] × QE_b	-0.135	-1.568	[2015q1] × QE_b	0.071	0.111
	[0.108]	[2.530]		[0.101]	[0.299]
[2019m12-2020m2] × QE_b	-0.273***	-3.577*	[2015q2] × QE_b	-0.088*	-0.282
	[0.078]	[2.100]		[0.051]	[0.187]
QE_b exposure measure	Continuous	Dummy		Continuous	Dummy
Bank FEs	Yes	Yes		Yes	Yes
Security-time FEs	Yes	Yes		Yes	Yes
Size	Yes	Yes		Yes	Yes
ECB lending	Yes	Yes		Yes	Yes
Observations	535,068	535,068		483,228	483,228
Number of securities	501	501		433	433
R-squared	0.013	0.013		0.011	0.011

The dependent variable is the value traded (in EUR) for security *s* by bank *b* in month *t* and normalized by total assets (in EUR million), where a security is defined at the ISIN level. We include only marked-to-market security that are PSPP eligible throughout the entire sample (i.e., the 12-month window around the announcement). The variable QE_b is the PSPP exposure of bank *b* calculated as of August 2019 (columns 1-2) or December 2014 (columns 3-4). In columns 1 and 3, QE_b is defined as the ratio of marked-to-market eligible securities to total assets. In column 2, the variable QE_b is a dummy equal to one for banks in the top tercile of the distribution of marked-to-market PSPP-eligible securities relative to total assets, and results are reported relative to banks in the bottom tercile. In column 4, QE_b is a dummy equal to one for banks in the top 15% of the distribution of marked-to-market PSPP-eligible securities relative to total assets. Standard errors are clustered at the bank and ISIN level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 12: Interest rates on new term loans

	2019 announcement (1)		2015 announcement (2)
[2019m3]× QE_b	-0.459		
	[0.381]		
[2019m4] × QE_b	-0.492		
	[0.368]		
[2019m5] × QE_b	-0.371	[2014q2] × QE_b	-0.893
	[0.305]		[0.960]
[2019m6] × QE_b	-0.286		
	[0.340]		
[2019m7] × QE_b	-0.463		
	[0.323]		
[2019m9] × QE_b	-0.934**	[2015q1] × QE_b	-1.523***
	[0.429]		[0.457]
[2019m10] × QE_b	-0.411		
	[0.340]		
[2019m11] × QE_b	-0.217		
	[0.342]		
[2019m12] × QE_b	-0.609*	[2015q2] × QE_b	-0.957
	[0.352]		[0.590]
[2020m1] × QE_b	0.210		
	[0.281]		
[2020m2] × QE_b	-0.301		
	[0.300]		
Bank FEs	Yes		Yes
Firm-time FEs	Yes		Yes
Size	Yes		Yes
ECB lending	Yes		Yes
Observations	14,574		9,451
R-squared	0.801		0.791

The dependent variable is the interest rate on new term loans by bank *b* to firm *f* in month *t* (column 1) or quarter *t* (column 2). In column 1, the variable QE_b is a dummy equal to one if a bank is in the top tercile of the distribution of marked-to-market eligible securities over assets as of August 2019, and the results are reported relative to banks in the bottom tercile. In column 2, QE_b is a dummy equal to one if a bank is in the top 15% of the distribution of marked-to-market eligible securities over assets as of December 2014. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 13: New lending relationships—the extensive margin

	2019 announcement (1)		2015 announcement (2)
[2019m3-2019m5] × QE_b	-0.001	[2014q2] × QE_b	-0.012
	[0.009]		[0.020]
[2019m9-2019m11] × QE_b	0.027**	[2015q1] × QE_b	0.041**
	[0.012]		[0.016]
[2019m12-2020m2] × QE_b	0.030	[2015q2] × QE_b	0.066*
	[0.020]		[0.036]
Bank FEs	Yes		Yes
Firm FEs	Yes		Yes
Time FEs	Yes		Yes
Size	Yes		Yes
ECB lending	Yes		Yes
Observations	442,460		359,045
R-squared	0.668		0.699

The dependent variable is a dummy equal to one if a loan application by firm *f* to bank *b* in month *t* is granted between *t* and *t*+3 (i.e., we observe a new credit relationship in the credit register in the month of the application or in the next three months). In column 1, the variable QE_b is a dummy equal to one if a bank is in the top tercile of the distribution of marked-to-market eligible securities over assets as of August 2019, and the results are reported relative to the bottom tercile. In column 2, QE_b is a dummy equal to one if a bank is in the top 15% of the distribution of marked-to-market eligible securities over assets as of December 2014. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 14a: Bank-by-province evidence, 2019

	(1)	(2)	(3)		(4)
	All loans	Intensive margin loans	Extensive margin loans		Extensive margin loans
[2019m3] × C_p	-0.025	-0.052	-1.211		
	[0.059]	[0.064]	[3.222]		
[2019m4] × C_p	-0.070	-0.064	-4.391	[2012m3-5] × C_p	-2.262
	[0.063]	[0.065]	[2.796]		[1.430]
[2019m5] × C_p	-0.088	-0.094	-3.255		
	[0.055]	[0.061]	[3.567]		
[2019m6] × C_p	-0.029	-0.067	-2.555		
	[0.088]	[0.088]	[3.357]		
[2019m7] × C_p	0.018	-0.012	0.167		
	[0.069]	[0.077]	[3.998]		
[2019m9] × C_p	-0.012	0.006	-8.696*		
	[0.080]	[0.083]	[4.437]		
[2019m10] × C_p	-0.083	-0.103	-4.309	[2019m9-11] × C_p	-3.198*
	[0.082]	[0.083]	[3.497]		[1.838]
[2019m11] × C_p	-0.048	-0.040	-0.269		
	[0.059]	[0.060]	[3.066]		
[2019m12] × C_p	-0.043	-0.040	-5.140		
	[0.071]	[0.073]	[3.330]		
[2020m1] × C_p	-0.087	-0.110	-0.589	[2019m12-2020m2] × C_p	-0.660
	[0.103]	[0.105]	[3.204]		[1.098]
[2020m2] × C_p	-0.018	-0.023	0.581		
	[0.080]	[0.083]	[3.110]		
Bank-month FEs	Yes	Yes	Yes		Yes
Province FEs	Yes	Yes	Yes		Yes
Observations	4,184	4,154	2,067		2,067
R-squared	0.272	0.259	0.145		0.134

The dependent variable is the change in the log of disbursed loans for the branches of bank *b* in province *p* in month *t*. The sample includes only non-exposed banks, that is, those in the bottom tercile of the distribution of marked-to-market PSPP-eligible securities over total assets as of August 2019. The variable C_p is the competition index defined as the loan market share of PSPP-exposed banks in province *p*. Standard errors are clustered at the bank and province level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 14b: Bank-by-province evidence, 2015

	(1)	(2)	(3)		(4)
	All loans	Intensive margin loans	Extensive margin loans		Extensive margin loans
[2014m7] × C_p	-0.002	0.024	-0.588		
	[0.035]	[0.036]	[1.216]		
[2014m8] × C_p	-0.018	0.007	0.871	[2014q3] × C_p	0.505
	[0.030]	[0.032]	[0.913]		[0.181]
[2014m9] × C_p	-0.004	0.018	-2.506		
	[0.031]	[0.034]	[1.608]		
[2014m10] × C_p	-0.041	-0.007	-1.617		
	[0.048]	[0.051]	[2.050]		
[2014m11] × C_p	0.004	0.031	-0.725		
	[0.051]	[0.055]	[0.887]		
[2015m1] × C_p	-0.054*	-0.024	-2.553*		
	[0.032]	[0.031]	[1.265]		
[2015m2] × C_p	-0.024	0.001	-0.544	[2015q1] × C_p	-0.943**
	[0.037]	[0.043]	[1.190]		[0.359]
[2015m3] × C_p	0.002	0.024	-1.952***		
	[0.023]	[0.026]	[0.690]		
[2015m4] × C_p	-0.003	0.026	-1.717		
	[0.040]	[0.040]	[1.434]		
[2015m5] × C_p	-0.001	0.025	-0.758	[2015q2] × C_p	-0.089
	[0.032]	[0.039]	[0.564]		[0.130]
[2015m6] × C_p	-0.064***	-0.041	-0.051		
	[0.017]	[0.025]	[1.500]		
Bank-month FEs	Yes	Yes	Yes		Yes
Province FEs	Yes	Yes	Yes		Yes
Observations	14,313	14,304	9,066		9,066
R-squared	0.145	0.133	0.135		0.134

The dependent variable is the change in the log of disbursed loans for the branches of bank *b* in province *p* in month *t*. The sample includes only non-exposed banks, that is, those in the bottom 85% of the distribution of marked-to-market PSPP-eligible securities over total assets as of December 2014. The variable C_p is the competition index defined as the loan market share of PSPP-exposed banks in province *p*. Standard errors are clustered at the bank and province level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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INTERNET APPENDIX

A. Historical cost vs. mark-to-market exposures

This appendix provides additional results and details about the effect of the PSPP on bank lending and how this effect is mediated by the macroprudential accounting rules. In particular, we report the full list of coefficients of the regressions in column 3 of Table 3 (2019 announcement) and column 3 of Table 4 (2019 announcement). In each of those regressions, we have considered two exposure measures—one given by the eligible securities that were marked-to-market and another given by the eligible securities valued at historical cost, and both normalized by total assets—and have interacted them with time dummies centered on the PSPP announcement month.

The results are reported in Table A1 below. Column 1a and 1b report the coefficients of the historical cost and mark-to-market exposure of the 2019 announcement, respectively. Column 2a and 2b report the coefficients of the historical cost and mark-to-market exposure of the 2015 announcement, respectively.

For the 2019 announcement, the results of the historical cost exposure measure are similar to those of the broad exposure shown in column 1 of Table 3. That is, we find a pre-trend (average March-July 2019 = 0.07, p-value = 0.00), and the September and October coefficients are not statistically different from the pre-trend (difference = 0.01 for both September and October, p-values = 0.59 and 0.85 for September and October, respectively). In other words, we find no difference between the pre- and post-announcement months. For the marked-to-market measure, the results are essentially identical to those derived in column 2 of Table 3. That is, lending at banks with higher holdings of marked-to-market eligible securities increases immediately after the announcement, in September 2019, and we observe no pre-trends.

For the 2015 announcement, the exposure based on historical cost displays a pre-trend, similar to the 2019 result. In particular, several coefficients have negative and statistically significant values before the announcement, and the July-November 2014 average is significant as well (July-November 2014 average = -0.07, p-value = 0.043). Some of the coefficients in the post-announcement period are also statistically significant, but the sign and magnitude are the same as those in the pre-announcement months. In particular, in the announcement month and the three following months (i.e., January-April 2015), none of the coefficients are statistically different from

the July-November 2014 average. Overall, we find no difference between the pre- and post-announcement period for the exposure measure that uses securities valued at historical cost. For the exposure based on mark-to-market accounting, reported in column 2a, the coefficients are the same as those reported in column 3 of Table 4. In particular, we find no pre-trends (average July-Nov 2014: 0.179, p-value = 0.357) and the January 2015 coefficient is significantly greater than the July-November 2014 average (difference=0.324, p-value: 0.000).

Taken together, these results show that banks increased their lending in response to the PSPP only when they had higher holdings of marked-to-market eligible securities, whereas we detect no effects on lending based on eligible securities valued at historical cost.

Table A1: Intensive margin, accounting rule and research design, 2019 announcement

	(1a) Historical cost	(1b) Mark-to-market		(2a) Historical cost	(2b) Mark-to-market
[2019m3]× QE_b	-0.011	0.025	[2014m7]× QE_b	-0.055	0.112
	[0.019]	[0.083]		[0.039]	[0.131]
[2019m4] × QE_b	0.169***	0.104	[2014m8] × QE_b	-0.171***	0.291
	[0.043]	[0.139]		[0.053]	[0.188]
[2019m5] × QE_b	0.046**	0.079	[2014m9] × QE_b	-0.017	0.286
	[0.022]	[0.058]		[0.053]	[0.228]
[2019m6] × QE_b	0.001	0.050	[2014m10] × QE_b	-0.089*	-0.046
	[0.035]	[0.125]		[0.050]	[0.240]
[2019m7] × QE_b	0.122***	0.017	[2014m11] × QE_b	-0.019	0.249
	[0.040]	[0.129]		[0.059]	[0.267]
[2019m9] × QE_b	0.076**	0.216**	[2015m1] × QE_b	-0.102**	0.503***
	[0.034]	[0.094]		[0.049]	[0.186]
[2019m10] × QE_b	0.077*	-0.223	[2015m2] × QE_b	-0.089**	0.196
	[0.044]	[0.238]		[0.035]	[0.187]
[2019m11] × QE_b	-0.039	0.109	[2015m3] × QE_b	0.011	0.063
	[0.034]	[0.112]		[0.055]	[0.151]
[2019m12] × QE_b	0.056**	0.320***	[2015m4] × QE_b	-0.091**	0.144
	[0.025]	[0.090]		[0.040]	[0.172]
[2020m1] × QE_b	0.118***	0.062	[2015m5] × QE_b	-0.125***	0.122
	[0.039]	[0.128]		[0.047]	[0.186]
[2020m2] × QE_b	-0.033**	0.028	[2015m6] × QE_b	0.009	0.061
	[0.014]	[0.049]		[0.055]	[0.114]
Observations	8,346,934			5,867,308	
R-squared	0.370			0.394	
Bank FEs	Yes			Yes	
Firm-time FEs	Yes			Yes	
Size	Yes			Yes	
ECB lending	Yes			Yes	

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. Columns 1a and 1b refer to one single specification that analyzes to the 2019 announcement and includes two measures of exposures—one based on eligible securities valued at historical cost as a fraction of total assets, and the other based on eligible securities marked to market as a fraction of total assets. Columns 2a and 2b refer to one single specification that analyzes to the 2015 announcement and includes two measures of exposures—one based on eligible securities valued at historical cost as a fraction of total assets, and the other based on eligible securities marked to market as a fraction of total assets. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

B. Bank characteristics and exposure to other policies: variable definitions

We now describe in detail the construction of the set of bank characteristics and bank exposure to other policies that we use in the robustness analysis of Section 4.3 and 4.4.

Holding of non-eligible securities. This variable is defined as securities that were not PSPP-eligible as a fraction of total assets, as of August 2019 or December 2014 for the 2019 and 2015 announcement, respectively.

TLTRO III exposure (2019 analysis). TLTRO III was initially announced in March 2019, and on September 12 of the same year, the ECB reduced the interest rate and extended the maturity of the loans under this program. Lending under the TLTRO III program, however, had not been disbursed yet as of the September 12—the program was organized based on auctions, with the first one scheduled to be settled on September 25, 2019. Thus, to control for the effects of this TLTRO III announcement, we construct a measure of the TLTRO III borrowing allowance, along the lines of (Benetton and Fantino 2021). For each bank, the borrowing allowance is capped at three times the amount of *eligible loans* of each bank, where *eligible loans* denotes the stock of loans to non-financial corporations, households, and non-profits, except loans to households for house purchases, as of 28 February 2019; eligible loans that had been self-securitized (i.e., where the asset-backed securities resulting from the securitization are fully retained) could also be counted.[32] We normalize the borrowing allowance by total assets.

TLTRO I exposure (2015 analysis). We control for the amount that banks borrowed from the ECB in the September and December 2014 TLTRO auctions, as a fraction of total assets. We approximate the amount borrowed in the September 2014 TLTRO auctions using the change in the stock of long-term ECB borrowing between August and September 2014 (i.e., borrowing with residual maturity greater than two years), and similarly for the December 2014 auction.

[32] The TLTRO III program was organized in seven auctions, and the borrowing capacity at each auction decreased by the amount borrowed in the previous auctions. For additional details, see Decision (EU) 2019/1311 of the European Central Bank of 22 July 2019.

Negative interest rates and net interbank position. On June 5, 2014, the ECB announced a reduction in the deposit rate that brought its level below zero. To control for the possible effects of the ECB's negative interest rate policy. We follow (Bottero, Minoiu et al. 2020) and approximate the exposure to the negative interest rate policy as the net interbank position, computed as interbank loans minus deposits with a maturity of up to one week, normalized by total assets. For the 2019 analysis, we use data as of June 2019—the latest available data before the September announcement. For the 2015 analysis, we use data as of March 2014, that is, the latest available data before the negative interest rate policy was implemented for the first time in June 2014.

Exposure to covered bonds (CB) and asset-backed securities (ABS) purchase program. We measure exposure to this program in two ways. First, we compute the holdings of CB and ABS relative to total assets. For the 2019 analysis, we use data as of August 2019 (i.e., the month before the September 2019 announcement). For the 2015 analysis, we use data as of August 2014 (i.e., the month before the CB and ABS program was announced for the first time). Second, we use a dummy equal to one for banks that have originated CB or ABS between August 2017 and August 2019 (for the 2019 analysis) and between August 2012 and August 2014 (for the 2015 analysis).

Exposure to the CSPP. We compute banks' holdings of eligible corporate-sector securities relative to total assets, as of August 2019. Because this program was announced for the first time in 2016, we do not consider it for the analyses of the 2015 PSPP announcement.

Exposure to the two-tier reserve system policy. Under the two-tier system that was announced on September 12, 2019, a fraction of banks' holdings of liquidity in excess of the required reserves is exempt from the negative deposit facility rate. In particular, excess reserves up to six times the reserve requirement earn zero interests, whereas reserves above that limit are subject to the negative interest rate on ECB deposits.[33] This system gives rise to an advantage for banks with excess reserves amounting to less than six times the required reserves. That is, a bank with such

[33] For additional details, see https://www.ecb.europa.eu/mopo/two-tier/html/index.en.html and Deutsche Bundesbank "*The two-tier system for reserve remuneration and its impact on banks and financial markets*" Monthly Report, January 2021.

low holdings could borrow from a bank with excess reserves above the limit—which would pay a negative rate to deposit at the ECB—and increase its reserves without incurring in the negative rate. We thus construct an *unused allowance* variable defined as

$$\max\{0,6*(\text{reserve requirement})-\text{excess reserves})\}$$

which captures a banks' ability to exploit the new two-tier system. We compute this variable using the last available data prior to the announcement, and we include it in our regression to control for this policy.[34] Because the two-tier reserve system was announced for the first time in 2019, we do not consider it for the analyses of the 2015 PSPP announcement, similar to the CSPP.

Comprehensive assessment. Between November 2013 and October 2014, the ECB conducted a comprehensive assessment, which included both an asset quality review and a stress test. We control for the comprehensive assessment in our 2014-15 analysis. Among the 95 banks in the sample, 7 banks were subject to the assessment.[35] We construct a dummy and set it equal to one for the banks subject to the assessment.

Governance rules. In 2014-15, some banks were subject to special governance rules (i.e., *amministrazione controllata*), and that the top management personnel at those banks was appointed by the Bank of Italy. Out of the 95 banks in the sample of the 2014-14 analyses, 4 were subject to these rules. We construct a dummy equal to one for such banks.

[34] The ECB requires that banks meet reserve requirements on average during each *maintenance period*, with each period typically lasting several weeks. For our purposes, we use data on reserve requirement and excess reserves for the maintenance period starting July 31, 2019, and ending September 17, 2019. While this period includes a few business days after the announcement of September 12, the data represent an average of daily figures that refer almost entirely to the pre-announcement period.

[35] Bank of Italy, "Risultati dell'esercizio di 'valutazione approfondita' (Comprehensive Assesment)," press release, October 26, 2014, https://www.bancaditalia.it/media/comunicati/documenti/2014-02/cs_261014.pdf.

C. Ruling out anticipatory bias, additional test

This appendix conducts an additional robustness check to rule out anticipatory bias. We use the exposure dummies, and we compare banks that were highly exposed both one month and seven months before the announcement (i.e., banks whose exposure dummies computed one and seven months before the announcement are both equal to one) with those that were in the bottom category of exposure both one and six months before the announcement. Table F.1 shows that the outcome is essentially identical to that of the baseline analysis.

Table F.1: (Lack of) anticipatory bias, exposure one and six months before the announcement

	2019 announcement		2015 announcement
	(1)		(2)
[2019m3]× QE_b	0.890	[2014m7]× QE_b	0.305
	[0.972]		[0.652]
[2019m4] × QE_b	0.139	[2014m8] × QE_b	0.337
	[2.029]		[0.622]
[2019m5] × QE_b	1.020	[2014m9] × QE_b	0.677
	[0.673]		[0.585]
[2019m6] × QE_b	1.917	[2014m10] × QE_b	-0.925
	[1.549]		[0.917]
[2019m7] × QE_b	0.031	[2014m11] × QE_b	-0.434
	[1.929]		[0.928]
[2019m9] × QE_b	2.853***	[2015m1] × QE_b	1.708**
	[0.945]		[0.739]
[2019m10] × QE_b	0.963	[2015m2] × QE_b	-0.137
	[0.948]		[0.718]
[2019m11] × QE_b	2.149	[2015m3] × QE_b	0.231
	[1.541]		[0.514]
[2019m12] × QE_b	3.441***	[2015m4] × QE_b	-0.095
	[0.654]		[0.554]
[2020m1] × QE_b	-0.046	[2015m5] × QE_b	-0.600
	[1.925]		[0.721]
[2020m2] × QE_b	0.029	[2015m6] × QE_b	0.235
	[0.326]		[0.497]
Exposure as of	August 2019 × February 2019		December 2014 × June 2014
Bank FEs	Yes		Yes
Firm-time FEs	Yes		Yes
Size	Yes		Yes
ECB lending	Yes		Yes
Observations	8,346,934		5,867,308
R-squared	0.370		0.394

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

D. Controlling for banks' characteristics correlated with exposure

This appendix presents the results of controlling for the banks' characteristics that display some correlation with exposure (see Section 4.4 for details about the links between banks' characteristics and exposure measures).

In all the analyses, we include the controls in the regressions by interacting each of them with time dummies centered around the announcement month. We perform all the robustness check both with the continuous and dummy exposure measures.

Tables D.1 and D.2 focus on the 2019 announcement, using the continuous and dummy measure, respectively. In each table, we control for the net interbank position, cash and reserves, tier 1 ratio, exposure to the CSPP program, and exposure to the two-tier reserve system measured by the unused reserve allowance (see Appendix B for variable definitions). The results of the baseline regression are unchanged.

Table D.3 focuses on the 2015 announcement, and controls for the bank characteristics that are related with the measure of exposure at that time, that is, tier 1 capital ratio and the securitization dummy (see Appendix B for variable definitions). The results are again unchanged.

Finally, Table D.4 performs an additional robustness check. We control for banks' holdings of securities that are not eligible to be purchased under the PSPP program, both for 2019 and 2015. The concern here is that there might be general equilibrium effects that arise through the prices of non-eligible securities as a result of the announcement, and that such effects might in turn affect bank lending. The control is again included by interacting it with time dummies centered around the announcement month. The outcome shows that our main results are unchanged when performing this additional test.

Table D.1: Controlling for banks' characteristics, 2019 announcement, continuous exposure

	(1)	(2)	(3)	(4)	(5)
[2019m3]× QE_b	0.018	0.023	0.048	0.023	0.038
	[0.083]	[0.078]	[0.091]	[0.074]	[0.086]
[2019m4] × QE_b	0.183	0.106	0.157	0.175	0.105
	[0.165]	[0.161]	[0.179]	[0.164]	[0.169]
[2019m5] × QE_b	0.095	0.085	0.102	0.099	0.089
	[0.068]	[0.067]	[0.069]	[0.067]	[0.067]
[2019m6] × QE_b	0.052	0.043	0.087	0.053	0.059
	[0.115]	[0.125]	[0.137]	[0.112]	[0.133]
[2019m7] × QE_b	0.073	0.046	0.064	0.070	0.018
	[0.137]	[0.149]	[0.151]	[0.137]	[0.146]
[2019m9] × QE_b	0.242**	0.245**	0.234**	0.250**	0.224**
	[0.110]	[0.116]	[0.111]	[0.108]	[0.110]
[2019m10] × QE_b	-0.182	-0.071	-0.317	-0.182	-0.251
	[0.224]	[0.153]	[0.310]	[0.220]	[0.259]
[2019m11] × QE_b	0.096	0.112	0.130	0.100	0.127
	[0.107]	[0.114]	[0.122]	[0.101]	[0.120]
[2019m12] × QE_b	0.342***	0.339***	0.379***	0.346***	0.331
	[0.095]	[0.106]	[0.111]	[0.098]	[0.102]
[2020m1] × QE_b	0.108	0.071	0.101	0.104	0.055
	[0.141]	[0.146]	[0.156]	[0.133]	[0.146]
[2020m2] × QE_b	0.019	0.032	0.052	0.020	0.033
	[0.048]	[0.051]	[0.054]	[0.048]	[0.051]
Net interbank position	Yes	No	No	No	No
Cash and reserves	No	Yes	No	No	No
Tier 1 ratio	No	No	Yes	No	No
CSPP exposure	No	No	No	Yes	No
Unused reserve allowance	No	No	No	No	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes
Firm-time FEs	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
ECB lending	Yes	Yes	Yes	Yes	Yes
Observations	8,346,934	8,346,934	8,346,934	8,346,934	8,346,934
R-squared	0.369	0.370	0.370	0.369	0.370

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. The variable QE_b is constructed as the value of PSPP-eligible securities subject to mark-to-market accounting relative to total assets, as of August 2019. Tier 1 ratio denotes Tier 1 capital relative to risk-weighted assets. See Appendix B for the definition of net interbank position, CSPP exposure, and unused reserve allowance. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table D.2: Controlling for banks' characteristics, 2019 announcement, dummy exposure

	(1)	(2)	(3)	(4)	(5)
[2019m3]× QE_b	0.836	0.854	1.400	0.607	1.310
	[0.977]	[0.972]	[1.046]	[0.817]	[1.069]
[2019m4] × QE_b	0.100	-0.205	-0.309	0.414	-1.867
	[1.861]	[1.740]	[1.829]	[1.704]	[1.315]
[2019m5] × QE_b	0.880	0.829	1.104	0.997	0.542
	[0.738]	[0.686]	[0.785]	[0.716]	[0.732]
[2019m6] × QE_b	1.394	1.369	2.074	1.104	1.905
	[1.522]	[1.553]	[1.763]	[1.270]	[1.879]
[2019m7] × QE_b	0.152	0.034	0.204	0.503	-1.384
	[1.763]	[1.713]	[1.829]	[1.545]	[1.418]
[2019m9] × QE_b	2.630**	2.616**	2.823**	2.717**	2.160**
	[1.069]	[1.034]	[1.108]	[1.069]	[1.052]
[2019m10] × QE_b	0.668	1.144	-0.427	0.065	-0.376
	[1.024]	[1.501]	[1.630]	[1.420]	[1.328]
[2019m11] × QE_b	1.865	1.945	2.586	1.636	2.802*
	[1.479]	[1.497]	[1.656]	[1.209]	[1.610]
[2019m12] × QE_b	3.403***	3.367***	4.129***	3.457***	3.206***
	[0.720]	[0.705]	[0.890]	[0.770]	[0.757]
[2020m1] × QE_b	-0.289	-0.451	-0.504	0.248	-1.891
	[1.828]	[1.757]	[1.784]	[1.568]	[1.376]
[2020m2] × QE_b	-0.225	-0.158	0.198	-0.251	0.050
	[0.372]	[0.378]	[0.463]	[0.380]	[0.466]
Net interbank position	Yes	No	No	No	No
Cash and reserves	No	Yes	No	No	No
Tier 1 ratio	No	No	Yes	No	No
CSPP exposure	No	No	No	Yes	No
Unused reserve allowance	No	No	No	No	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes
Firm-time FEs	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
ECB lending	Yes	Yes	Yes	Yes	Yes
Observations	8,346,934	8,346,934	8,346,934	8,346,934	8,346,934
R-squared	0.369	0.369	0.369	0.369	0.370

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. The variable QE_b is a dummy equal to one for banks in the top tercile of the distribution of eligible securities subject to mark-to-market accounting relative to total assets, as of August 2019, and the results are relative to banks in the bottom tercile. Tier 1 ratio denotes Tier 1 capital relative to risk-weighted assets. See Appendix B for the definition of net interbank position, CSPP exposure, and unused reserve allowance. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table D.3: Controlling for banks' characteristics, 2015 announcement

	(1)	(2)	(3)	(4)
[2014m7]× QE_b	0.012	0.076	0.125	0.350
	[0.146]	[0.134]	[0.651]	[0.626]
[2014m8] × QE_b	0.141	0.212	0.383	0.565
	[0.162]	[0.168]	[0.587]	[0.551]
[2014m9] × QE_b	0.210	0.275	0.800	0.819
	[0.230]	[0.235]	[0.580]	[0.538]
[2014m10] × QE_b	-0.196	-0.039	-1.068	-0.615
	[0.212]	[0.223]	[0.874]	[0.729]
[2014m11] × QE_b	0.122	0.326	-0.721	0.053
	[0.264]	[0.257]	[0.893]	[0.731]
[2015m1] × QE_b	0.388**	0.442**	1.693**	1.772**
	[0.169]	[0.178]	[0.717]	[0.723]
[2015m2] × QE_b	0.062	0.165	-0.124	0.129
	[0.160]	[0.176]	[0.653]	[0.624]
[2015m3] × QE_b	-0.026	0.052	0.276	0.321
	[0.178]	[0.154]	[0.594]	[0.538]
[2015m4] × QE_b	-0.015	0.104	-0.210	0.099
	[0.156]	[0.163]	[0.539]	[0.527]
[2015m5] × QE_b	-0.049	0.105	-0.777	-0.271
	[0.173]	[0.174]	[0.705]	[0.621]
[2015m6] × QE_b	0.090	0.051	0.518	0.165
	[0.124]	[0.128]	[0.500]	[0.472]
QE_b exposure measure	Continuous	Continuous	Dummy	Dummy
Tier 1	Yes	No	Yes	No
Securitization dummy	No	Yes	No	Yes
Bank FEs	Yes	Yes	Yes	Yes
Firm-time FEs	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes
ECB lending	Yes	Yes	Yes	Yes
Observations	5,623,310	5,867,308	5,623,310	5,867,308
R-squared	0.396	0.394	0.396	0.394

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. The variable QE_b is the ratio of marked-to-market eligible securities to total assets as of December 2014 (columns 1-2) or a dummy equal to one for the banks in the top 15% of the distribution (columns 3-4). Tier 1 ratio denotes Tier 1 capital relative to risk-weighted assets. See Appendix B for the definition of the securitization dummy. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table D.4: Controlling for holdings of non-eligible securities

	2019 announcement			2015 announcement	
	(1)	(2)		(3)	(4)
[2019m3]× QE_b	0.022	0.801	[2014m7]× QE_b	0.079	0.498
	[0.081]	[0.962]		[0.132]	[0.616]
[2019m4] × QE_b	0.176	0.145	[2014m8] × QE_b	0.184	0.835
	[0.161]	[1.834]		[0.169]	[0.573]
[2019m5] × QE_b	0.100	0.855	[2014m9] × QE_b	0.277	0.884
	[0.064]	[0.724]		[0.233]	[0.596]
[2019m6] × QE_b	0.052	1.353	[2014m10] × QE_b	-0.104	-0.478
	[0.114]	[1.516]		[0.231]	[0.939]
[2019m7] × QE_b	0.071	0.210	[2014m11] × QE_b	0.231	0.217
	[0.136]	[1.737]		[0.269]	[0.966]
[2019m9] × QE_b	0.250**	2.638**	[2015m1] × QE_b	0.445**	1.757**
	[0.107]	[1.035]		[0.174]	[0.673]
[2019m10] × QE_b	-0.185	0.495	[2015m2] × QE_b	0.145	0.040
	[0.224]	[1.174]		[0.179]	[0.753]
[2019m11] × QE_b	0.098	1.845	[2015m3] × QE_b	0.066	0.588
	[0.105]	[1.469]		[0.158]	[0.533]
[2019m12] × QE_b	0.340***	3.481***	[2015m4] × QE_b	0.092	-0.011
	[0.098]	[0.695]		[0.164]	[0.618]
[2020m1] × QE_b	0.110	-0.261	[2015m5] × QE_b	0.040	0.007
	[0.141]	[1.808]		[0.176]	[0.660]
[2020m2] × QE_b	0.020	-0.230	[2015m6] × QE_b	0.067	0.160
	[0.048]	[0.359]		[0.127]	[0.547]
QE_b measure	Continuous	Dummy		Continuous	Dummy
Bank FEs	Yes	Yes		Yes	Yes
Firm-time FEs	Yes	Yes		Yes	Yes
Size	Yes	Yes		Yes	Yes
ECB lending	Yes	Yes		Yes	Yes
Non-eligible securities	Yes	Yes		Yes	Yes
Observations	8,346,934	8,346,934		5,867,308	5,867,308
R-squared	0.369	0.370		0.394	0.394

The dependent variable is the change in the log of disbursed loans from bank b to firm f in month t. The variable QE_b is the PSPP exposure of bank b calculated as of August 2019 (columns 1-2) or December 2014 (columns 3-4). In columns 1 and 3, QE_b is defined as the ratio of marked-to-market eligible securities to total assets. In column 2, the variable QE_b is a dummy equal to one for banks in the top tercile of the distribution of marked-to-market PSPP-eligible securities relative to total assets, and results are reported relative to banks in the bottom tercile. In column 4, QE_b is a dummy equal to one for banks in the top 15% of the distribution of marked-to-market PSPP-eligible securities relative to total assets. Non-eligible securities denote the holdings of securities that are not eligible to be purchased under the PSPP program and are classified as available-for-sale or in the trading book, as a ratio of total assets. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

E. Mechanism, 2019 announcement: additional results

This appendix repeats the analyses of Section 5 about the mechanism behind the effects of the PSPP on bank lending, focusing on the 2019 announcements and using the dummy measure of exposure. Similar to Section 5, we interact banks' exposure to the PSPP with the level of capitalization, and we control for banks' liquidity both directly and interacting it capital. Table E.1 shows that the results confirm the pattern identified in Table 10, columns 1 and 2, using the continuous measure of exposure.

Table E.1: Mechanism, capital and liquidity, 2019 announcement, dummy exposure

	2019 announcement	
	(1)	(2)
[2019m9] × QE_b	1.354*	1.442*
	[0.776]	[0.794]
[2019m9] × QE_b × [Tier 1 ratio]$_b$	-0.564**	
	[0.234]	
[2019m9] × QE_b × [CET1 ratio]$_b$		-0.421*
		[0.227]
[2019m9] × QE_b ×[liquidity/assets]$_b$	-0.182	-0.159
	[0.179]	[0.202]
[2019m9] × QE_b × [Tier 1 ratio]$_b$×[liquidity/assets]$_b$	0.077	
	[0.053]	
[2019m9] × QE_b × [CET1 ratio]$_b$×[liquidity/assets]$_b$		0.070
		[0.054]
Bank FEs	Yes	Yes
Firm-time FEs	Yes	Yes
Size	Yes	Yes
ECB lending	Yes	Yes
Observations	8,295,389	8,295,389
R-squared	0.370	0.370

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. The variable QE_b is a dummy equal to one if a bank is in the top tercile of the distribution of mark-to-market eligible securities relative to total assets, as of August 2019, and the results are reported in comparison to banks in the bottom tercile. Tier 1 ratio is the ratio of Tier 1 capital to risk-weighted assets; CET1 ratio is the ratio of CET1 capital to risk-weighted assets; and liquidity denotes central bank reserves. The regression in column 1 includes [2019m9] ×[Tier 1 ratio]$_b$, [2019m9] ×[liquidity/assets]$_b$, and [2019m9] ×[Tier 1 ratio]$_b$×[liquidity/assets]$_b$, and similarly for regressions in column 2. Tier 1 ratio, CET1 ratio, and liquidity/assets are normalized by their respective first quartile levels. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

F. Interest rates data and intensive margin results

This appendix repeats the baseline intensive margin analysis of the 2019 and 2015 PSPP announcements (i.e., column 2 of Table 3 and column 2 of Table 4), using only the subset of banks for which interest rate data is available. The results are presented in Table F.1. Columns 1 and 3 use the continuous measure of exposure, and columns 2 and 4 use the dummy. The outcome is essentially unchanged in comparison to the full sample of Table 3 and 4, column 3 and 4.

Table F.1: Intensive margin, subsample of banks with interest rate data

	2019 announcement			2015 announcement	
	(1)	(2)		(1)	(2)
[2019m3]× QE_b	0.008	0.997	[2014m7]× QE_b	0.028	-0.091
	[0.102]	[1.031]		[0.148]	[0.697]
[2019m4] × QE_b	0.220	0.063	[2014m8] × QE_b	0.235	0.817
	[0.212]	[2.019]		[0.207]	[0.602]
[2019m5] × QE_b	0.097	0.940	[2014m9] × QE_b	0.331	0.658
	[0.082]	[0.778]		[0.263]	[0.556]
[2019m6] × QE_b	0.091	1.589	[2014m10] × QE_b	-0.133	-1.228
	[0.151]	[1.636]		[0.275]	[1.003]
[2019m7] × QE_b	0.090	0.207	[2014m11] × QE_b	0.265	-0.264
	[0.181]	[1.908]		[0.337]	[0.992]
[2019m9] × QE_b	0.294**	2.853**	[2015m1] × QE_b	0.502**	1.813**
	[0.138]	[1.136]		[0.216]	[0.803]
[2019m10] × QE_b	-0.286	0.162	[2015m2] × QE_b	0.220	0.072
	[0.272]	[1.074]		[0.204]	[0.716]
[2019m11] × QE_b	0.133	2.085	[2015m3] × QE_b	0.073	0.197
	[0.138]	[1.575]		[0.186]	[0.501]
[2019m12] × QE_b	0.436***	3.677***	[2015m4] × QE_b	0.061	-0.458
	[0.115]	[0.768]		[0.182]	[0.547]
[2020m1] × QE_b	0.127	-0.145	[2015m5] × QE_b	0.075	-0.394
	[0.186]	[1.971]		[0.228]	[0.778]
[2020m2] × QE_b	0.010	-0.216	[2015m6] × QE_b	0.049	0.198
	[0.059]	[0.371]		[0.139]	[0.516]
Bank FEs	Yes	Yes	Bank FEs	Yes	Yes
Firm-time FEs	Yes	Yes	Firm-time FEs	Yes	Yes
Size	Yes	Yes	Size	Yes	Yes
ECB lending	Yes	Yes	ECB lending	Yes	Yes
Observations	8,164,365	8,164,365	Observations	5,510,652	5,510,652
R-squared	0.371	0.371	R-squared	0.401	0.401

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* at time *t*. The variable QE_b is the PSPP exposure of bank *b* calculated as of August 2019 (columns 1-2) or December 2014 (columns 3-4). In columns 1 and 3, QE_b is defined as the ratio of marked-to-market eligible securities to total assets. In column 2, the variable QE_b is a dummy equal to one for banks in the top tercile of the distribution of marked-to-market PSPP-eligible securities relative to total assets, and results are reported relative to the bottom tercile. In column 4, QE_b is a dummy equal to one for banks in the top 15% of the distribution of marked-to-market PSPP-eligible securities relative to total assets. Standard errors are clustered at the bank level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

G. Spillovers on lending supply

In this appendix, we build on (Berg, Reisinger, et al. 2021) and we provide empirical evidence that further supports our main results. The analysis of (Berg, Reisinger, et al. 2021) show that spillovers from treated units could bias the estimates of a difference-in-difference specification, and in our setting, the concern is that spillovers from PSPP-exposed banks could affect the lending behavior of other banks. This appendix shows that this issue is not a concern for our estimates.

To conserve on the number of parameters to be estimated, we condense the difference-in-difference design of our baseline specification: Because most of the response to the PSPP was relatively immediate, we create an indicator variable that equals 1 in September 2019 and January 2015 for the 2019 and 2015 announcement, respectively, and 0 otherwise. We then interact this indicator with our baseline PSPP exposure dummy measure and we estimate, for the 2019 announcement,

$$\Delta \log \mathrm{L}_{\mathrm{b,f,t}} = \beta[\mathrm{Sept2019}]\mathrm{QE}_{\mathrm{b}} + \beta^{\mathrm{C}}[\mathrm{Sept2019}](1 - \mathrm{QE}_{\mathrm{b}})\mathrm{C}_{\mathrm{p}} + \beta^{\mathrm{T}}[\mathrm{Sept2019}]\mathrm{QE}_{\mathrm{b}}\mathrm{C}_{\mathrm{p}} + \gamma[\mathrm{Sept2019}]Y_b + \delta \mathrm{Z}_{\mathrm{b,t}} + \psi_{\mathrm{b}} + \psi_{\mathrm{f,t}} + \varepsilon_{\mathrm{b,f,t}} \ ,$$

and a similar equation for the 2015 announcement. The variable QE_{b} is the exposure dummy based on marked-to-market holdings of eligible securities in the pre-announcement month, and C_{p} denotes the market share of QE-exposed banks in province *p* in which bank *b* is located, where by "exposed" we mean a bank with exposure dummy equal to one.[36]

Table G.1 presents the results. The baseline coefficient β, that captures the direct effect of exposure on bank lending, has a magnitude similar to the baseline estimate, and remains highly significant. The coefficients β^{C} and β^{T}, that capture spillovers on non-exposed and exposed banks in the same province, respectively, are very small and not significant. Thus, the results show that spillovers in the sense of (Berg, Reisinger, et al. 2021) do not affect our main estimates and results.

[36] Following the examples in (Berg, Reisinger, et al. 2021), we compute the market share of exposed banks in province *p* excluding bank *b* itself.

Table G.1: Ruling out spillovers on lending supply.

	(1)		(2)
[2019m9] × QE_b	1.882***	[2015m1] × QE_b	1.842***
	[0.435]		[0.573]
[2019m9] × $(1 - QE_b) \times C_p$	0.009	[2015m1] × $(1 - QE_b) \times C_p$	0.009
	[0.012]		[0.014]
[2019m9] × $QE_b \times C_p$	0.016	[2015m1] × $QE_b \times C_p$	0.032
	[0.034]		[0.110]
Bank FEs	Yes		Yes
Firm-time FEs	Yes		Yes
Size	Yes		Yes
ECB lending	Yes		Yes
Observations	8,302,689		5,867,308
R-squared	0.369		0.394

The dependent variable is the change in the log of disbursed loans from bank *b* to firm *f* in month *t*. In column 1, the variable QE_b is a dummy equal to one for banks in the top tercile of the distribution of marked-to-market PSPP-eligible securities relative to total assets as of August 2019, and results are reported relative to banks in the bottom tercile. In column 2, QE_b is a dummy equal to one for banks in the top 15% of the distribution of marked-to-market PSPP-eligible securities relative to total assets as of December 2014. The variable C_p denotes the market share of QE-exposed banks (i.e., those for which the QE_b dummy is equal to one) in province *p* in which bank *b* is located, computed by excluding bank *b* itself. Standard errors are clustered at the province level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.