Collateral Easing and Safe Asset Scarcity: How Money Markets Benefit from Low-Quality Collateral [*]

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Abstract

We show that central bank lending against lower quality collateral can improve conditions in the money market. For identification we take advantage of a pandemic-related temporary extension of the collateral framework of the European Central Bank (ECB), which allows banks to pledge previously ineligible credit claims as collateral for refinancing operations. We use a difference-in-differences approach and exploit banks that do not mobilize credit claims ex ante as a control group. We find that banks affected by the temporary extension pledge newly eligible credit claims in order to reduce the encumbrance of high-quality marketable assets. Treated banks lend out these marketable assets as collateral in the repo market, which helps to alleviate asset scarcity.

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1 Introduction

Central banks provide credit against adequate collateral. An appropriate collateral framework is therefore a cornerstone for the implementation of monetary policy. Yet, there is no clear consensus about the optimal design of collateral policies (Bindseil & Papadia, 2006; Nyborg, 2017a,b). In fact, central banks' collateral frameworks differ greatly, from a narrow definition in the US to a very broad definition in the Eurozone.[1]

While an adequate collateral framework should primarily insure central banks against potential losses, recent work ascribes a more proactive role to collateral policies. They can act as a monetary policy tool through their impact on financial markets. For example, once an asset becomes eligible as central bank collateral, securities lending activity increases and bond yields decline, ultimately benefiting the issuer of the bond (Pelizzon et al., 2024). In this study, we highlight that the transmission of collateral policies to financial markets is not limited to such direct eligibility effects but even works across broader asset classes. We show that a temporary relaxation in the Eurosystem's collateral rules for credit claims increases the availability of government bonds for private collateral markets which, in turn, stimulates overall market activity. The additional supply of these bonds is particularly valuable when the market has structural deficit of high-quality assets. Central banks can thus promote market functioning by accepting a broader range of non-tradable, low-quality assets as eligible collateral. Moreover, lower levels of asset scarcity can help to safeguard a smooth transmission of monetary policy through the repo market (Bindseil & Logan, 2019).

As an element of pandemic-related emergency operations, the ECB Governing Council passed a temporary extension of its additional credit claim (ACC) framework on April 7, 2020. The main intention of such collateral easing measures is that a broader set of eligible collateral amplifies banks' access to central bank liquidity and ultimately supports bank lending to the real economy.[2] Prior studies find evidence consistent with this conjecture: the first ACC framework in 2012 had positive effects on both lending volumes (Cahn

[1] A set of reports issued by the Bank for International Settlements gives a broad overview on central bank collateral frameworks (e.g. BIS, 2013, 2015). Bindseil et al. (2017) gives a more explicit account of the Eurosystem's collateral framework. Tamura & Tabakis (2013) discuss the use of credit claims within this framework.

[2] Under the current fixed-rate, full allotment liquidity operations, banks can borrow any amount given that they have enough suitable collateral at their disposal. Hence, the main constraint for accessing central bank funding is collateral availability.

et al., 2017) and lending rates (Mésonnier et al., 2022). A second effect of the ACC program, which has received considerably less attention, is that a shift towards a broader set of eligible collateral can also support repo market functioning to the extent that it increases the amount of high-quality collateral available to the market. Choi et al. (2021) theoretically model this channel: While lending against high-quality collateral is optimal for central banks for limiting operational losses, it can adversely affect trading activity in money markets as high-quality collateral gets locked up with the central bank rather than being deployed in repo transactions. Faced with such a trade-off, central banks might optimally choose to accept collateral of lower quality with the goal of improving the pool of collateral available to the market.

In this paper, we exploit the extension of the ACC framework towards a broader set of eligible assets as a laboratory to study said link between central banks' collateral policies and the private collateral market. For identification purpose, we exploit the fact that some banks actively use the option to hand in credit claims as collateral when participating in monetary policy operations while other banks do not. A temporary relaxation of collateral rules should then encourage the former group of banks to pledge newly eligible credit claims instead of high-quality marketable assets to obtain central bank funding.[3] The reason for this shift is that such marketable assets carry higher opportunity costs because they are liquid and sought-after assets for other private market transactions. With fewer marketable high-quality assets being encumbered for central bank borrowing, banks could lend out these assets to earn a bond's specialness premium while investing the borrowed cash at a higher risk-free rate. Importantly, banks' additional bond supply could promote overall repo market functioning in that it helps to reduce the shortage of safe assets in private collateral markets.

Our main results are in line with the above conjecture and the outlined theoretical predictions of Choi et al. (2021): In our first set of results, we show that extended collateral eligibility through the ACC framework indeed incentivizes banks to change the composition of their collateral pool (BIS, 2015). More specifically, banks with an existing pool of non-marketable collateral at the Eurosystem pledge more non-marketable assets in the form of additional credit claims once the framework extension is in place. At the

[3]The decision to hand in credit claims or not is persistent at the individual bank level. Indeed, none of the banks in our sample starts to pledged credit claims only after the ACC extension. Hence, these banks remain unaffected by the policy change which makes them a suitable control group for our study.

same time, the set of banks which hands in these credit claims as collateral reduces the pledging of marketable assets, in particular government bonds, relative to other banks. In a back-of-the-envelope calculation, we estimate that an additional EUR 100 billion of government bonds would have been encumbered for central bank funding absent this change in the pledging behaviour. Additional tests further reveal that banks are especially reluctant to pledge government bonds with a higher specialness in the repo market. This indicates that banks seem to have some kind of pecking order when deciding which assets to pledge for central bank liquidity and that elevated demand for a bond in the repo market seems to play an important role in this ordering.

In our second set of results, we document how a central bank's collateral policy impacts repo market activity. We start off with a simple test to empirically confirm one of the core trade-offs in Choi et al. (2021). As predicted by their theory, we find that collateralized lending of central banks has a meaningful impact on private collateral markets, as evidenced by significantly lower securities lending volumes and lower collateral reuse for more intensely pledged bonds.

Based on the exogenous variation in banks' collateral pledging behaviour induced by the ACC framework extension, we then provide evidence that collateral policies can impact securities lending activities in a causal manner. More specifically, we document that those banks which have the opportunity to hand in additional credit claims after the collateral framework extension – and make use of it as we have shown – also become more active in the repo market. They increase their securities lending volumes, both in absolute terms but also net of their securities borrowing activity. Importantly, the granularity of our dataset enables us to include security x time fixed effects in the majority of our tests. This allows us to directly control for borrowing demand and other time-varying fundamental of a particular bond on any given day. We can thus ascribe the observed increase in securities lending volumes to differences in banks' lending supply and their preceding collateral choice for obtaining central bank funding.[4] Studying the heterogeneity of the treatment effect across banks, we further establish that the effect is stronger for banks with a larger buffer of collateral in their collateral accounts with the central bank and for banks with ex-ante riskier loan portfolios.

[4]This strategy is inspired by the inclusion of firm-time fixed effects (Khwaja & Mian, 2008) in much of today's banking literature in order to disentangle credit demand from credit supply. Also see Elsayed et al. (2023) or Kaldorf & Poinelli (2024) for a similar approach in a related context.

Digging deeper, we find that the effects on lending activity are conditional on the bank's ownership share of a bond while they do not depend on how intensely the bank has pledged the bond for refinancing operations. This sheds some light on how exactly banks respond to the new collateral framework: They do not remove encumbered assets from their collateral pools at the Eurosystem but rather lend out a larger part of their bond holdings as they no longer need to retain them as collateral for central bank funding. Hence, in our case, collateral policy transmission to the collateral market does not work through a bank's existing collateral pool but rather through its potential collateral pool for new refinancing operations. Such a finding can be informative for the optimal sequence of policy measures: accepting a broader set of collateral *before* launching attractive (targeted) refinancing operations, like the ones in 2020, does not only ensure sufficiently broad access to central bank funding but it can also, as we show here, limit distortions in private collateral markets.

Finally, we test whether the results that are observable at the bank-level also feed through to the bond level. We find this indeed to be the case. Bonds which are held by a higher fraction of banks with non-marketable collateral at the Eurosystem experience an increase in overall lending volume, an increase in their reuse, a decline in their specialness, and a decline in their rate dispersion. This result underscores that choices made by individual banks in response to the collateral framework extension also matter for market outcomes. We therefore conclude that the Eurosystem's decision to relax the eligibility criteria for credit claims has helped to alleviate safe asset scarcity of in the repo market.

Overall, our results demonstrates that a central bank's choice to lend against low-quality, non-tradable collateral can have a positive spillover effect on the "plumbing" of collateral markets. To the extent that a well-functioning repo market is required to smoothly transmit interest rate decisions to financial markets (Fritsche et al., 2020) – by limiting dispersion in rate pass-through to banks' funding costs for example (Nguyen et al., 2023) – a broader set of eligible collateral can support the transmission of monetary policy. A central bank's collateral framework should thus be viewed as a supplementary tool for the conduct of monetary policy, all the more so when balance sheets and collateral pools are as sizeable as in recent years or, put differently, when central banks themselves contribute to safe asset scarcity. As such, our findings can bear implications for new operating frameworks of monetary policy implementation, as far as they are different variants of a floor system with correspondingly large balance sheets and ample liquidity (Brandao-Marques & Ratnovski, 2024).

Our findings can further inform the currently ongoing policy debate about prepositioning of collateral. Proposals by King (2016) and G30 Working Group on the 2023 Financial Crisis (2024) aim to overcome a shortcoming of current Lender-of-Last-Resort (LoLR) regimes by limiting contagion ex ante in a world of nearly instantaneous bank runs. These proposals require banks to post enough collateral to cover, after haircuts, all runnable liabilities, e.g. deposits and other short-term debt. Central banks would support this with an efficient collateral management system, which could lead to a situation where even more assets have to become eligible as collateral.[5] In this regard, our paper can provide valuable insights about potential effects of an (even) broader collateral framework on repo markets and on trade-offs between smoother monetary policy transmission and adequate protection of central bank balance sheets against potential losses in a new LoLR regime.

1.1 Related Literature

The role of collateral for the conduct of monetary policy has been analyzed both theoretically and empirically. On the theoretical side, Koulischer & Struyven (2014) argue that a lack in the quantity or quality of collateral can affect interest rates even when the monetary policy stance remains constant. Looser collateral policies can mitigate this effect. Departing from a slightly different angle, Choi et al. (2021) argue that lending against low-quality collateral can further be optimal when taking into account the spillover effect of a narrow framework on money markets. One of the central contributions of this paper is to provide empirical evidence for this theoretical prediction.

Empirical studies on central banks' collateral frameworks can be broadly divided into two groups. One group of papers looks at the pledging behaviour of banks under a broad collateral framework. Based on collateral data from the Eurosystem, Fecht et al. (2016) document that the central bank receives more risky and more illiquid collateral from banks. Using data from the Bank of England, De Roure & McLaren (2021) reach

[5]Central banks would effectively become lender of first resort while ideally protecting themselves against credit losses. This would, however, crucially depend on an adequate calibration of haircuts on pledged collateral and on complementary reforms in banking regulation and supervision, which are beyond the remit embedded in central banks' operation frameworks.

the same conclusion. In a similar vein, Drechsler et al. (2016) show that lender-of-last-resort operations from the Eurosystem involve riskier types of collateral, particularly pledged by weakly capitalized banks. In contrast to that, Lenzi et al. (2023) find no connection between the financial soundness of Italian banks and the composition of their collateral pools in more recent times. Cassola & Koulischer (2019) take a somewhat different perspective: they model a bank's collateral choice after a change in the haircut policy of the central bank and find that higher haircuts on low-rated collateral lead to reduced use of the same type of collateral. We extent this literature by unveiling a similar effect after a temporary relaxation in collateral rules for low-quality collateral. Moreover, our identification strategy allows us to document in a more stringent way that a broader collateral framework incentivizes banks to not only shift the composition of their collateral pool towards lower quality, non-marketable assets but to put a larger fraction of unencumbered marketable assets to productive use elsewhere at the same time.

The second group of papers investigates how changes to the collateral framework of central banks affect bank lending. Hüttl & Kaldorf (2022) examine the introduction of the single list of collateral in 2007 and find that harmonized collateral rules stimulate loan supply. Barthélémy et al. (2017) highlight that banks which pledge more illiquid collateral have a more resilient lending activity. Using data on French banks, a set of papers exploits the initial introduction of additional credit claims to document an outwards shift of credit supply for newly eligible firms (Bignon et al., 2016; Mésonnier et al., 2022). Our study is distinct from the above as we focus on securities lending instead of bank lending. While the latter is clearly a primary objective for the conduct of monetary policy, a sound repo market with limited levels of asset scarcity can support a smooth transmission of monetary policy impulses (Nguyen et al., 2023). Our finding that a broader collateral framework can be beneficial for repo market functioning, in that it improves the supply of high-quality assets for private transactions instead of locking them up at the central bank, adds an important new dimension to this context.

In this regard, we also relate to the literature on asset scarcity in repo markets. A number of papers has shown that central banks themselves induce scarcity through their asset purchase programs (Arrata et al., 2020; Aggarwal et al., 2021; Baltzer et al., 2022). On the other hand, adequate central bank policies – such as securities lending facilities (Greppmair & Jank, 2023) or less restrictive collateral rules as we highlight – can help to at least partially mitigate these scarcity effects again.

On top of that, we extend prior work on the value of asset pledgeability. For example, Chen et al. (2023) provide evidence on how eligibility affects bond yields in the Chinese corporate bond market. Corradin & Rodriguez-Moreno (2016) demonstrate that different eligibility criteria affect the relative pricing of otherwise similar bonds. In the context of repo markets, Pelizzon et al. (2024) document an increase in both supply and demand levels once corporate bonds become eligible as central bank collateral. The novelty of our studies is to show that changes in the eligibility of one particular asset class, non-traded credit claims, can create spillover effects to other classes and markets, in our case sovereign bonds traded in the secured money market.

Finally, our study contributes to the literature on unconventional central bank refinancing operations. A large number of studies in this field, e.g. Benetton & Fantino (2021) and Da Silva et al. (2021), focus on lending outcomes and whether such targeted measures are effective and in line with the stated objectives. Other aspects such as the collateral being posted for these operations, are typically left aside. One notable exception is Carpinelli & Crosignani (2021) who explicitly analyze the role of collateral eligibility for the transmission of central bank liquidity provision. We consider yet another aspect of this story: Instead of only looking at the assets which are being deployed as collateral to secure such funding, we are interested in the assets which are *not* being deployed. In doing so, we highlight that an extension of the collateral framework can create an effect across different asset classes and ultimately helps to safeguard the transmission process of monetary policy by improving supply conditions in the repo market.

The remainder of the paper is organized as follows. In Section 2, we discuss several aspects of collateral framework choices: the general rational of collateral frameworks, a theoretical setting for collateral framework choices and the specific collateral framework of the Eurosystem. In Section 3, we provide a description of our data sources and introduce our empirical setup, our identification strategy and a set of stylized facts. Section 4 presents our results on collateral pledging and securities lending behaviour of banks. Finally, we conclude in Section 5.

2 Collateral Frameworks - Background and Theory

2.1 Rational of collateral frameworks

Collateral frameworks are an integral part of how central banks provide liquidity to the financial system. A common principle of all collateral frameworks dates back to Bagehot (1873): Central banks should lend against good collateral at an appropriate price while managing the risk associated with such activity. This risk management aspect highlights the need to limit operational losses that could materialize when a counterparty defaults. It is reflected in the rate charged for the provision of liquidity, the access criteria to liquidity, and, most importantly, in the haircut schedules adopted to the collateral. Central banks differ in their design of collateral frameworks, which can be explained by differences in local factors such as (a) the financial market structure (bank-based versus market-based), (b) central bank legislation, and (c) the level of development of a country.

Collateral frameworks can be classified according to a number of aspects (see BIS (2013)). Those include: (i) counterparty eligibility, i.e. whether the lending operations or facilities are restricted to a selected few institutions (e.g. the primary dealer system in the US) or accessible for a broad set of counterparties like in the Eurosystem; (ii) uniform or differentiated collateral sets, i.e. whether a single collateral set is applicable to all operations like in the Eurosystem or whether the central bank is differentiating its eligible collateral set and assigning it to specific types of operations like in the US and UK; (iii) earmarked vs. pooled, i.e. whether collateral delivered is earmarked for specific loans or operations like in the UK or pooled whereby collateral is pledged into a pool, with lending backed by the value of the whole pool and not linked to individual assets (Eurosystem); (iv) acceptance of a narrow or a wide range of assets and issuer types, i.e. whether only certain types of eligible issuers are accepted (sovereigns or public sector) like in the case of open market operations in the US, or a wide range like in the Eurozone, where also obligations of financial and non-financial private sector entities are accepted, which can be marketable securities or even certain loans.

Generally speaking, the optimal collateral framework for a given central bank should strike a balance between a smooth conduct of monetary policy on the one hand and an adequate protection of the central bank balance sheet against potential losses on the other hand. In this respect, the increased scarcity of safe assets driven by liquidity regulation[6] and by the extensive asset purchase programs, which have made central banks the largest single owners of safe bonds, has brought up one additional argument: The acceptance of a more wide range of eligible assets can have positive side effects on the availability of safe assets for private market transactions. This can reduce asset scarcity, which might in turn be beneficial for a smooth monetary policy transmission.[7]

Before we turn to the empirical assessment of how a broader collateral framework might affect banks' collateral pledging and securities lending behaviour, we first describe related insights of the theoretical literature.

2.2 Theoretical Setting

It is well understood that a broadening of the set of collateral in times of crisis, when high-quality collateral has been exhausted, can have positive welfare effects (see Bindseil (2013), and Koulischer & Struyven (2014)). Recently, the theory presented in Choi et al. (2021) shows that central bank lending against low-quality collateral has an additional benefit in that it improves liquidity in money markets.

In our paper we conduct an empirical assessment of the theory of Choi et al. (2021), which we outline in the following, sticking closely to their exposition. Their model incorporates maturity transformation and collateral circulation and has four groups of agents: borrowers, lenders, outsiders in an anonymous money market, and a central bank.

Borrowers use collateral of either high or low quality to raise funds from lenders in order to finance projects with positive expected returns. Lenders can experience a liquidity shock in which case they need to borrow from outsiders against collateral. Outsiders do not know the exact quality of individual collateral but can only observe the average value of collateral in the market. Central banks lend against high-quality collateral.

If the average quality of collateral is too low, lenders face liquidity risk as they may not be able to obtain enough funds in the money market to finance all positive NPV projects. Banks with high-quality collateral would then prefer to borrow from the central bank

[6] The introduction of liquidity regulation (Liquidity Coverage Ratio, LCR, and Net Stable Funding Ratio, NSFR) after the GFC have created an increased demand for safe assets.

[7] See e.g. Nguyen et al. (2023), who show that the passthrough of policy rates to repo rates (which can, in turn, affect banks' collateralized funding costs to a varying degree), is hampered when government bonds are scarce.

because they want to avoid to be pooled with banks with low-quality collateral. On the one hand this would insure these banks against liquidity risk and leave central banks with little counterparty risk. On the other hand, because the central bank also lends against collateral, borrowing from the central bank reduces the pool of outstanding high-quality collateral. This, in turn, affects the functioning of private markets. Choi et al. (2021) then show that the positive direct effect of central bank lending can be more than offset by the negative indirect effect on markets and that it can be optimal for central banks to lend against low-quality collateral.

Based on the model of Choi et al. (2021) we are going to empirically test whether a central bank policy that broadens the collateral framework has spillover effects to the money market. While Choi et al. (2021) focus on the effect of a broader collateral framework on *cash- or liquidity-driven* money market transactions, our focus is on *security-driven* money market transactions, which is the more common type of transaction in the period under consideration (see for example ECB, 2021), where the underlying motive is to source a specific bond through a repo.

We use the Eurozone as laboratory for our empirical analysis in Section 4. We therefore turn to a description of the collateral framework in the Eurozone and also describe the extension of the ACC framework in April 2020, which we exploit as a natural experiment in our main empirical tests.

2.3 Institutional Background in the Eurozone

The collateral framework in the Eurozone is characterized by a broad set of counterparties that are eligible for refinancing operations. This is because the financial system in the Eurozone is bank-based. The collateral set is uniform and applicable to all operations.[8] Banks pledge their collateral into a pool and lending is backed by the value (post-haircut) of the entire pool. The Eurosystem accepts a wide range of assets and issuers (Eberl & Weber, 2014) in order to grant the very diverse set of counterparties a sufficient degree of access to central bank operations (Bindseil et al., 2017).[9] In general, banks can

[8] An exception is the Emerging Liquidity Assistance, ELA, where solvent but illiquid banks can pledge collateral of lower quality.

[9] The general documentation lays out the criteria that need to be fulfilled for securities to be acceptable as collateral (For more details see: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32014O0060&qid=1663161472069&from=EN.)

choose between marketable securities, such as government or corporate bonds, and non-marketable securities, such as credit claims (Tamura & Tabakis, 2013). Figure 1 depicts the composition of the Eurosystem's collateral pool over time by asset type. Marketable assets accounted for at least 75% of mobilised collateral up until the second quarter of 2020. Since then, the share of marketable assets decreased by around 10 percentage points with credit claims largely soaking up this share. Looking at credit claims as collateral in more detail, one can see that (a) credit claims represent the single largest asset class in the collateral pool since 2014 and that (b) their share steadily increased from 19% in 2013 to 33% in 2022, with a particular large jump in the first half of 2020. One likely reason for the significant increase in non-marketable collateral is the extension of the ACC framework in early April 2020.

ACCs are credit claims that do not fulfill all the eligibility criteria applicable under the general collateral framework. In contrast to the general collateral framework, which applies to the Eurosystem as a whole, ACC frameworks are country-specific. In 2011, the ECB approved an ACC framework for four countries for the first time in an attempt to alleviate the negative effects of rating downgrades during the sovereign debt crisis on the eligible collateral pool. On April 7, 2020 the ECB passed an extension of the framework, which now includes loans guaranteed by government schemes and loans with lower credit quality for a broader set of countries. While the main purpose of the extension is to give banks incentives to provide loans to the real economy, the program can in principle also have effects on the collateral composition of banks vis-a-vis the Eurosystem. The idea is that banks can now pledge additional credit claims instead of marketable securities as the latter feature higher opportunity costs owing to their higher liquidity and fungibility.

The marketable securities that remain unencumbered can in turn be used for other purposes, such as making them available for lending in the repo market. After all, banks can generates additional revenue through lending out their bond inventories, especially when a lot of bonds trade at a premium relative to the general collateral rate. Hence, the extension of the ACC framework might positively affect collateral markets when marketable securities are repoed out instead of being pledged in central bank refinancing operations. Increased availability of high-quality assets in the repo market can then help to alleviate asset scarcity as far as securities lending volumes rise and specialness premia fall as a consequence of the positive supply shock (a recent industry report by ICMA

(2021) mentions that collateral easing measures taken by the ECB indeed helped to reduce pressure on repo markets)

3 Empirical Setup

3.1 Identification Strategy

In order to identify how a broader collateral framework can affect banks' collateral pledging and securities lending behaviour, we start with a simple observation: some banks routinely pledge credit claims when they participate in the Eurosystem's refinancing operations while other banks exclusively pledge marketable assets. The reason for banks not to hand in credit claims as collateral can in principle be two-fold: First, there might be institutional restrictions like the bank's business model that prevents the bank from handing in credit claims. Second, there are additional costs and hurdles associated with the use of credit claims as collateral: extended documentation requirements, legal restrictions on the mobilisation or transferability of credit claims, less automated procedures for collateralisation, lack of standardisation, limited rating availability, limited secondary market activity, or legal uncertainty regarding the existence of the credit claim (see, e.g. Bundesbank, 2023; Tamura & Tabakis, 2013). These additional barriers, together with the fact that admission to the operating systems for submitting credit claims takes a certain time, make it rather unlikely that banks without any non-marketable collateral in their pool are going to start to pledge credit claims in the short-term or as a reaction to a temporary extension of the collateral framework. In other words, the decision to use credit claims as central bank collateral should not change with the natural experiment, which is key for our identification strategy to work. We verify this claim by checking whether any bank in our sample starts to hand in credit claims as collateral *only after* the collateral framework extensions. We find this not to be the case. This means that only a bank with a mixed collateral pool prior to the framework extension should benefit from the collateral easing measures while a bank whose collateral pool consists only of marketable assets should not be affected when additional credit claims become eligible as collateral. As a consequence, only the former type of bank should have the flexibility to shift its collateral pool towards previously ineligible credit claims while using available marketable securities, in particular high-quality bonds, elsewhere. Summing up, our identification strategy to pin down the effect of a central bank's collateral framework on repo market functioning consists of two major elements: (1) the ACC framework extension as a natural experiment and (2) the ex-ante composition of a bank's collateral pool at the Eurosystem to define our treatment group, that is banks with both marketable and non-marketable collateral in their pool, and our control group, that is banks without non-marketable collateral in their pool.

3.2 Stylized Facts

We underpin the proposed identification approach with a set of stylized facts about the collateral pledging behaviour of treated versus control banks before and after the introduction of the collateral easing package in April 2020. First, Figure 2 provides preliminary evidence consistent with a shift of treated banks' collateral pool towards non-marketable securities. For treated and control banks, the solid lines display the evolution of the total pool of collateral pledged in refinancing operations with the Eurosystem. Both groups expand their collateral pools to a similar degree in 2020 as a result of their increased usage of refinancing operations. The increase in the period before the ACC extension reflects participation in the first three operations of the bridge LTRO between March 17 and April 7, 2020. The increase in the post-period mainly relates to the fourth operation of the third TLTRO series on June 24, 2020.[10] A closer examination of the composition of the collateral pool of treated banks further shows that these banks pledge relatively more credit claims once the ACC framework is re-newed in April 2020. More specifically, we observe a decline in the fraction of marketable securities being pledged, as indicated by the dashed green line, and a concurrent increase in the fraction of additional credit claims being pledged, as indicated by the dashed yellow line.

While the pattern in Figure 2 depicts a move from marketable towards non-marketable collateral of lower credit quality, it does not yet reveal if all marketable assets are equally affected or if banks apply some kind of pecking order in deciding which securities to mobilise as collateral for refinancing operations. As a second stylized fact, we therefore

[10]The bridge LTRO was implemented against the background of the Covid-19 pandemic in order to immediately bridge the euro area financial system's liquidity needs until the fourth TLTRO-III operation, which settled on June 24, 2020 and had very favorable conditions.

take a closer look at the asset classes in the collateral pool of both groups.

Figure 3 condenses the main findings into one picture. Here, we break down the two substantial increases in the collateral pools of treated and control group in the pre- and post-ACC periods by more granular asset classes. We distinguish between four types of assets: marketable securities issued by central governments, other marketable securities, regular credit claims and additional credit claims. The decomposition for the control group is depicted in the upper part of Figure 3 and serves as a benchmark to see which type of assets are being mobilised to access central bank funding and whether banks without non-marketable collateral choose different collateral pools over time. In line with the conjecture that these banks should not be able to take advantage of the ACC framework extension but need to use collateral of higher quality instead, we see that they pledge substantial fractions of government bonds in both periods. Specifically, around 53% (77%) of central bank funding of these banks are backed by government bonds in the pre- and post-period, respectively.

For the subset of banks with non-marketable collateral, the picture looks quite different. As can be seen in the lower part of Figure 3, around 47% of central bank refinancing is backed by government bonds prior to the ACC extension. This number is strikingly similar to the control group, which gives us confidence that both groups' pledging behaviour is comparable absent the treatment. For the post-period, in turn, only 3% of refinancing is backed by government bonds. The remainder is made up of 12% other marketable assets, 30% regular credit claims and 55% additional credit claims (up from 10% in the pre-period). This shows that not only do banks in the treatment group move from marketable to non-marketable collateral, they more specifically pledge "low-quality" credit claims while keeping "high-quality" government bonds at their disposal. To get a sense of the economic magnitude of the effect, we conduct the following back-of-the-envelope calculation: We assume that without any modification to the collateral framework, treated banks would have maintained a stable composition of their collateral pool over time. We thus take the pre-period fraction of each asset class and multiply it with the post-period increase in central bank funding to get a counterfactual estimate for the amount of encumbered assets given the observed level of refinancing. Comparing this amount to the actual amount of encumbered assets shows that an additional EUR 100 billion of government bonds (equivalent to around 1% of total euro area government debt outstanding at the end of 2020) would have been locked up in the central bank's collateral pool absent the extension of the ACC framework.

3.3 Empirical Methodology

Our main empirical analysis proceeds in two steps. In the first step, we conduct a more formal test of the pledging behaviour of banks. Our main hypothesis is that banks which previously handed in credit claims as collateral benefit from the extension of the ACC framework insofar as they can now resort to a broader pool of eligible collateral. In deciding which collateral to pledge for refinancing operations, they should then optimally pledge the asset with the lowest opportunity cost first and only hand in assets with higher opportunity costs once the unencumbered holdings of other assets become more exhausted. While the argument itself sounds straightforward, it is challenging to provide exact estimates of an asset's pledging cost, even more so as the cost itself might be bank-specific and dependent on the other asset classes that a bank can choose from. In order to circumvent these issues, we focus on the difference between government bonds and non-government bonds. We argue that government bonds carry the highest opportunity costs across asset classes and that these costs are rather independent of idiosyncratic bank factors given their abundant use in repo markets and the central role they play in a regulatory context. Hence, we explicitly differentiate between government bonds and other bonds when we implement the following test:

$$CollPledged_{b,s,t} = \beta \times Post_t \times Treated_b \times Government_s + \mathbf{X}'_{b,t}\gamma + \alpha_{b,s} + \alpha_{s,t} + \epsilon_{b,s,t} \quad (1)$$

where the dependent variable $CollPledged_{b,s,t}$ is the nominal amount of bond s pledged by bank b in week t, scaled with the bond's amount outstanding. The main explanatory variables are: *Post*, which is a dummy variable that equals one for the time period after the extension of the ACC program on April 7, 2020 and zero otherwise, *Treated*, which is a dummy variable that equals one for banks which have non-zero mobilised non-marketable collateral as of the end of March 2020 and zero otherwise, and *Government*, which is a dummy variable that equals one when the bond is issued by a euro-area central government. We expect β to be negative, which would indicate that treated banks are more reluctant to pledge high-quality collateral, in the form of government bonds, relative to control banks once the modified ACC framework is in place because they now have a broader set of eligible collateral and can optimally use high-quality assets elsewhere.

Regarding money market activity, we then hypothesize that treated banks increase their securities lending volume more than the control group because of two complementary factors: First, treated banks should have additional government bonds at their disposal as they can resort to a broader disjunct set of collateral with lower opportunity costs for central bank refinancing operations as compared to other banks. Second, they have an incentive to supply these additional government bonds to the market as demand for safe assets is very high in the period under consideration due to high levels of asset scarcity.[11] Therefore, an expansion of securities lending activities is likely to translate into additional income for treated banks. Based on the above considerations, we run the following difference-in-differences regression to test for a link between the design of a central bank's collateral framework and repo market activity:

$$Y_{b,s,t} = \beta_1 \times Post_t \times Treated_b + \mathbf{X}'_{b,t}\gamma + \alpha_{b,s} + \alpha_{s,t} + \epsilon_{b,s,t} \tag{2}$$

The main coefficient of interest in this specification is again β, which captures any differences in the repo market activities of treated versus control banks in the context of the ACC framework extension.

Irrespective of whether we analyze collateral pledging behaviour or securities lending activities of banks, we include *bond* $\times$ *time* fixed effects in all our regressions to control for any security-specific time-varying observable or unobservable characteristics (e.g., liquidity, risk, issuance amount, lending/borrowing demand, asset purchases) and *bank* $\times$ *bond* fixed effects to control for any unobserved matching between characteristics of banks and bonds (i.e., a bank's preference for a particular security). Furthermore, we control for a host of bank-specific, time-varying characteristics to account for remaining differences in observables that are not spanned by the chosen fixed effects structure but could nevertheless affect our results. Specifically, our set of controls includes bank's equity, loans to non-financial firms, bonds held, central bank reserves, (T)LTRO uptakes (all scaled

[11] While Sylvestre & Coutinho (2020) provide tentative evidence along these lines, they also acknowledge the difficulties in modelling the relationship between Eurosystem collateral and the repo market due to the heterogeneities in banks' balance sheets and collateral mobilisation strategies.

by total assets) and the natural logarithm of total assets. Finally, standard errors are clustered at the bank and time level.

3.4 Data Description

For the empirical analysis, we collect data from multiple sources and construct a unique data set which combines granular information on a bank's collateral pool, its bond holdings and its repo market activity. With regard to bank collateral for monetary policy operations, we have access to the "Use of Collateral Database" (UCDB), a proprietary database from the Eurosystem which contains detailed information on the collateral pool of each bank accessing the Eurosystem's balance sheet. For marketable instruments, we observe weekly snapshots of the amount of collateral a bank pledges (both in nominal and haircut-adjusted terms) at the individual bond-level. For non-marketable instruments, i.e. credit claims, we have two distinct data points per bank at the same weekly frequency: the total amount of regular credit claims that are used as collateral as well as the amount of additional credit claims. The sample period is January 2020 to July 2020, i.e. six month around the ACC program. We exclude banks with less than EUR 10 billion of total assets over the sample period to make sure that small banks with a special business (e.g. provision business) do not bias our results. After applying this filter, we have information on the collateral pool of 129 banks from the entire euro area in the UCDB sample.

The second main dataset we use is the securities holdings statistics group data (SHS-G), which contains a detailed view on the security portfolios of more than 100 significant euro area banking institutions. Security-level holdings are reported at a quarterly frequency for both the entity- and the group-level. We use the data to gather information on individual bond holdings at the bank level and the ownership structure of bonds at the instrument level.

Finally, with regard to banks' money market activities, we focus on the secured segment of the market. The data set we use is the money market statistical reporting data (MMSR). The MMSR contains transaction-level information on repo market activity of the largest euro area banks. We observe both lending and borrowing activities of each bank. The data covers an extensive set of information regarding counterparties, collateral, and the terms of each transaction. For this paper, we restrict our attention to the most common types of repo trades: First, we only consider centrally cleared trades, which make up the majority of trades, since we want to abstract from counterparty risk. Second, we only consider trades with a one-day maturity, i.e. trades in the overnight-next, tomorrow-next, and spot-next segment, which represent the most liquid segment of the repo market. Third, we only consider repo transactions with collateral issued by central governments which is by far the most commonly traded collateral in the market. We end up with 37 banks in the MMSR sample, which are responsible for the largest share of money market activity in the euro area. To match the frequency of the other datasets, we collapse the MMSR to a weekly level by summing up individual deal volumes and taking volume-weighted averages of individual deal rates for a given bank-bond pair.

We complement our three main datasets with bank balance sheet information from the Individual Balance Sheet Indicators (IBSI), additional bond characteristics from the centralised securities database (CSDB) and the eligible assets database (EADB), time series information on a bond's amount outstanding, auction dates and futures delivery dates from Thomson Reuters Eikon, and proprietary Eurosystem information on asset purchases and central bank refinancing operations.

Before we proceed, we want to highlight the key advantage of our data. The level of granularity in both the UCDB and the MMSR allows us to match the data at both the bank as well as at the bond level: Matching the data bank-by-bank is essential for connecting the pledging and repo trading behaviour of individual banks. Analyzing both actions in conjunction enables us to pin down whether banks adjust their activities in response to the broader collateral framework, accounting for any confounding factors at the bond level. Matching the data bond-by-bond on the other hand allows us to track for each bond the amount which is locked in as collateral at the Eurosystem and the amount which is lent and borrowed in private market transactions. Hence, we can also quantify whether any changes across all banks or subgroups thereof have a material impact on the bonds which serve as collateral or whether the effects we observe for individual banks average out in the aggregate. Combining these two dimensions should thus help us to establish a well-founded case for any interaction between central bank's collateral frameworks and market functioning.

3.5 Descriptive Statistics

Descriptive statistics for the treatment and control group are display in Table 1. In Panel A we report summary statistics for the UCDB sample of banks. Treated banks are somewhat larger. They have a larger fraction of loans to non-financial corporations on their balance sheet and hold a smaller fraction of bonds and reserves on their assets side. Treated banks have a slightly larger equity ratio (8.3%) as compared to control banks (7.8%). The same goes for their LTRO ratio (3.6% versus 1.2%). When working with this sample (i.e. in Table 3), we aim to control for any differences in observables in our empirical setup.

For the MMSR sample (Panel B), both treated and control banks are very comparable along all observable bank characteristics. We formally test for the presence of differences with a two sample t-test in Table IA.1 in the Internet Appendix and detect no significant differences. Table 2 shows additional summary statistics for the MMSR data. While we acknowledge that the control group in the MMSR sample consists of only five banks, we want to stress that these banks are responsible for a sizeable 20% of securities lending volume in the MMSR. Hence, a comparison between securities lending activities of treated and control banks within a difference-in-difference setting can still be reasonably fair as long as both groups are comparable along other important dimensions. This seems to be the case in our setting.

4 Results

4.1 Collateral Pledging Behavior

In a first set of tests, we exploit the difference-in-differences regression setup from equation (1) to study the collateral pledging behavior of banks, that is, we conduct a more formal analysis of Figure 3. The results of this exercise are summarized in Table 3. The dependent variable is the nominal amount of a marketable security pledged by a bank with the Eurosystem scaled with the bond's amount outstanding. We only include observations in the regression sample for which we observe a non-zero holding of the bond in the respective quarter.[12] When there is no pledging for a given bank-bond pair in week t, we set the pledged amount to zero.

As a starting point, we report coefficient estimates of a simpler version of equation (1), where we do not distinguish between government bonds and other bonds, in column (1). We obtain a small and statistically insignificant coefficient estimate. Next, we split the sample into other marketable assets (e.g. corporate bonds, covered bonds, ABS, etc.) (column 2) and government bonds (column 3). We obtain an insignificant coefficient in column (2) and a statistically significant and negative coefficient in column (3). Thus, treated banks pledge less high-quality collateral (government bonds) relative to control banks, which is in line with the hypothesis developed above. Instead of a sample split, in column (4) we include a triple interaction with an indicator variable for government bonds. We obtain a negative and significant coefficient estimate for the triple interaction. These estimates confirm the result of the sample split.[13] To gauge the economic significance of the effect, we multiply the coefficient in column (3) with the sample mean of the government bonds' amount outstanding. We find that treated banks reduce their pledging of an average-sized bond by a sizable EUR 1.7 billion relative to the control group.

All in all, the findings in Table 3 are reassuring given that government bonds are the main form of collateral in money market transactions. This sets the stage for the repo market analysis in the next section. However, before we turn to studying banks' securities lending behavior, we take another look at the subset of government bonds that banks can pledge as collateral in our sample to examine whether banks have some kind of pecking order when deciding which assets to pledge for central bank funding. To do so, we interact the *Post* $\times$ *Treated* dummy with a set of bond-level characteristics. Since we are interested in whether banks take into account the opportunity cost of privately lending out the bond instead of using it as central bank collateral, we limit our attention to characteristics which serve as proxies for the demand for a certain bond in the repo market. The results are presented in Table 4. In column (1), our first demand proxy

[12] Due to differences in the reporting frequencies of the UCDB and SHS-G, the dataset contains observations with non-zero pledging but zero holding for a given week. This could for example be the case if a bank pledged a bond throughout the quarter but does no longer hold the bond at the end of the quarter. By applying the non-zero holdings filter, we abstract from such cases. Nevertheless, our results stay similar if we do not impose the filter.

[13] In the Online Appendix, we conduct an additional test for pre-trends in the pledging behavior of treatment and control group by replacing the *Post* dummy with a set of dummy variables for each month. Figure IA.2 confirms the absence of such trends and lends further support to our identification strategy.

is the bond's securities lending volume in the past week. Although we find the triple interaction to be negative, which would be in line with banks being more reluctant to pledge bonds with a high demand in the repo market, the coefficient is insignificant. The same is true when we use the securities lending volume net of borrowing in column (2). When we use the bond's specialness, on the other hand, we find the triple interaction to become significant at the 5% level (column 3). This suggests that the propensity to use a bond as central bank collateral decreases with the expected return on lending out the bond in the private market. In column (4), we further show that this result cannot be explained by other fundamental bond characteristics that might as well be related to a bond's specialness. Specifically, we orthogonalize specialness with respect to a bond's amount outstanding, time to maturity, a dummy for auction dates, a dummy for futures delivery dates, and a dummy for the on-the-run status of the bond. When we run the regression using this alternative specialness measure, we find a coefficient which is very comparable to the one in column (3).

4.2 Repo Market Activity

4.2.1 A Simple Test of Choi et al. (2021)

Before we turn to the estimation of regression equation (2) to examine whether the relaxation of the collateral framework in the Eurozone has an effect on repo market activity, we first run some preliminary regressions. We study whether there is an association between the collateral that a bank pledges and its repo market trading. We view this exercise as a rather direct test of Choi et al. (2021). Their theory predicts that collateralized central bank lending can negatively affect collateral markets to the extend that high-quality assets get locked up with the central bank. In expectation, more intense pledging of a bond should therefore be associated with lower availability of the bond in the money market, all else equal.

In Panel A of Table 5 we run regressions on a bank-bond level and saturate the model with bond-time, bank-time, and bank-bond fixed effects to control for time-varying and time-invariant unobservable factors at both the bank and the bond level. In column (1) we regress *Net Lending*, i.e. securities lent (repo) − securities borrowed (reverse repo) scaled by a bond's amount outstanding, on the variable *Collateral Pledged*, which is the amount pledged as collateral for refinancing operations with the Eurosystem, again scaled by the bond's amount outstanding. We use *Net Lending* as our main dependent variable as it allows us to capture both legs of money market trading and thus gives us a comprehensive picture of a bank's de facto bond supply to the repo market. The coefficient estimate is negative and significant under the 1 % significance level. This shows that for a given bond, there is indeed a negative association between a bank's repo market trading and the amount the bank has pledged as collateral with the Eurosystem. In column (2) the dependent variable is the gross securities lending volume. We obtain a significant coefficient estimate of a similar magnitude as in column (1) in this case. There is no significant effect on the gross securities borrowing amount (see column (3)). Taken together, this shows that the negative relationship between net repo market activity and *Collateral Pledged* in column (1) is indeed driven by a reduction in securities lending volumes and not by an increase in securities borrowing. In columns (4) and (5) we run the same regressions with the reuse rate and the reuse amount as dependent variables. The reuse amount and the reuse rate are defined as in Jank et al. (2022) or in FSB (2017). We do not detect significant coefficient estimates for *Collateral Pledged*. In column (6) we examine the bond's specialness as dependent variable. The coefficient estimate of *Collateral Pledged* is not statistically different from zero in this case either.

In Panel B of Table 5 we run the same set of regressions on the bond level.[14] As opposed to Panel A, we now get a negative, but statistically insignificant effect of *Collateral Pledged* on *Net Lending* in column (1). However, columns (2) and (3) provide a straightforward explanation for this result. We obtain a negative and statistically significant coefficient estimate for *Collateral Pledged* in column (2), where the dependent variable is gross lending. In column (3), where we use gross borrowing, the coefficient estimate of *Collateral Pledged* is also negative and statistically significant but the magnitude is smaller (in absolute terms) compared to the estimate in column (2). This suggests that in contrast to the individual bank level, where only one leg of repo trading is affected, bond-level lending and borrowing volumes move more in lockstep, with a change in the former being offset by a similar change in the latter. Results in columns (4) and (5) of Panel

[14]Testing at both the bank-bond and the bond-level is important as the former allows for a very stringent setting with bank-time and bond-time fixed effects, while the latter better underscores the economic relevance of any effect as individual choices made by different banks only matter for market outcomes when they add up and do not cancel out in the aggregate.

B further emphasize this finding. Here, we take the reuse rate and the reuse amount as our dependent variable, respectively. We obtain a negative and statistically significant coefficient estimate (under the 10% significance level) in both cases. Thus, more intense usage of a bond as central bank collateral is associated with lower reuse of this bond in the repo market. This result makes sense economically given that we observe a decline in both securities lending and borrowing activities for pledged bonds. Finally, we do not detect a coefficient estimate that is statistically different from zero in column (6), where the bond specialness is the dependent variable.

4.2.2 Difference-in-Difference Test

As explained before, the introduction of the modified ACC framework creates a source of exogenous variation in banks' collateral pledging behaviour vis-à-vis the Eurosystem. At the same time, the decision to extend the ACC framework is unlikely to be directly influenced by prevailing repo market conditions at that time. After all, the main intention behind the program was to amplify banks' access to central bank liquidity in order to support bank lending to the real economy. Based on these insights, we use the policy change in order to investigate whether the association between collateral pledging and repo market activities of banks that we have documented in the previous section also allow for a more causal interpretation.

To do so, we turn to the estimation of regression equation (2) and examine whether treated banks, i.e. those with non-marketable collateral in the period before the policy change, scale up their securities lending activities in the money market in response to the collateral easing package of April 7, 2020. Table 6 presents evidence consistent with this reasoning. In column (1) we document that *Net Lending*, defined as before, of the same bond in the same week increases significantly for treated banks. This is in line with the hypothesis developed in Section 3.3. The effect is statistically significant under the 5% significance level. The coefficient estimate suggests that treated banks increase their bond lending to the repo market by 0.5015 percentage points. In economic terms, this corresponds to 5% relative to the sample standard deviation of *Net Lending* (0.5015 / 10.225). Thus, we find that treated banks indeed offer their high-quality assets in the repo market after the ACC extension. Importantly, as we include *bond* $\times$ *time* fixed effects in our regression setup, we are able to control for bond demand (similar to the Khwaja &

Mian (2008) estimator in the banking literature). This means that we can attribute the observed increase in securities lending volume to differences in *banks' bond supply*, which is a crucial piece of evidence for our story.

Next, we confirm that the effect on *Net Lending* is driven by a change in the securities lending activity of banks. Using the gross securities lending volume as dependent variable in column (2), we find a positive and highly statistically significant coefficient. At the same time, the coefficient estimate of the same regression with gross securities borrowing amount as dependent variable is not statistically different from zero (column (3)). These results are reasonable given that treated banks have more government bonds at their disposal because they do no longer pledge these bonds as central bank collateral under the extended collateral framework. Unencumbered high-quality assets are then sourced to the repo market which increases a bank's bond lending activity. Bond borrowing, on the other hand, remains unaffected by the policy change. Equivalently to Table 5, in columns (4) and (5) we repeat the same regressions with the reuse rate and the reuse amount as dependent variables. However, we do not find an effect for treated banks after the introduction of the ACC program. Finally, column (6) shows results for the specialness spread as dependent variable. We obtain a negative coefficient estimate, which is not statistically different from zero.

Parallel Trends. The validity of our difference-in-differences setup hinges on the parallel trends assumption. Our *Post* dummy takes the value of 1 from April 2020 onwards, i.e., after the extension of the ACC program. Hence, our main coefficient of interest measures the difference in repo market activities between pre- and post-period as a function of the treatment status. To investigate the timing of the effect and whether the parallel trends assumption is met, we run the following dynamic version of regression (2):

$$Y_{b,s,t} = Treated_b \times \sum_{k=0}^{T} \beta_k \cdot D_t + \mathbf{X}'_{b,t}\gamma + \alpha_{b,s} + \alpha_{s,t} + \epsilon_{b,s,t} \tag{3}$$

where D_t is an indicator variable that equals one in month t, and zero otherwise, with March 2020 serving as the baseline effect. Standard errors are clustered at the bank and time level. Figure 4 shows that, prior to the ACC extension in April 2020, the interaction terms are small and not statistically significant. Afterwards, the estimates increase and remain statistically significant for the remaining sample period, which suggests that the collateral easing measures are an important driver of net securities lending volumes over an extended period of time.[15]

4.2.3 Heterogeneities

We present various additional heterogeneity analyses, by introduction conditional treatment dummies, to better understand which banks are increasing their securities lending activities. In column (1) of Table 7 we split the treatment dummy according to the median of the variable *Overcollateralization*, which we define as follows:

$$Overcollateralization = \frac{Collateral\ Pool\ Value\ after\ haircut - Refinancing\ Operations}{Collateral\ Pool\ Value\ after\ haircut} \tag{4}$$

Typically, a bank's collateral portfolio with the central bank is larger than the amount borrowed in refinancing operations. All else equal, a bank that holds a larger buffer of collateral in their collateral account with the central bank thus needs to pledge less additional collateral for a given amount of refinancing. This potentially increases the bank's incentives to use its high-quality assets for other purposes. Consistent with this line of reasoning, we find a somewhat larger effect on *Net Lending* for banks with a high overcollateralization ratio. The difference of the two coefficients (Treated-High versus Treated-Low) is significant at the 10% level.

Next, we construct the variable *Collateral Constraint*, which we define as follows:

$$Collateral\ Constraint = \frac{Amount\ of\ Collateral\ Pledged}{Amount\ of\ Collateral\ on\ Balance\ Sheet} \tag{5}$$

Banks that pledge all potentially eligible assets with the central bank, have a value of 'Collateral Constraint' equal to one, thus, being potentially constraint to obtain central bank funding.[16] We find a somewhat smaller coefficient estimate for banks that have

[15] In the Internet Appendix, we present an additional coefficient plot for the gross securities lending amount and get a very similar picture (see Figure IA.1).

[16] When a bank pledges all eligible assets but does not use them for refinancing operations, i.e. when it is highly overcollateralized, it is unlikely to be constraint already. We adjust the median split of high- vs low-*Collateral Constraint* accordingly by re-classifying banks with above-median *Overcollateralization* values to be part of the latter group.

below-median values of *Collateral Constraint*. However, the difference in the coefficients (Treated-High versus Treated-Low) is not statistically significant.

In column (3) we look at the share of credit claims (as a fraction of the total collateral pool) that a bank has prior to the ACC extension as another source of heterogeneity. The variable is inspired by Mésonnier et al. (2022), who use it as an opportunity cost measure. We find that the treatment effect is somewhat larger for banks with a larger credit claims share. However, the difference is again not statistically different from zero.

Lastly, we compute the variable *Portfolio Risk*, which is the volume-weighted credit quality step (CQS) of a bank's non-marketable collateral.[17] In other words, the variable measures the average credit risk of a bank's loan portfolio to non-financial corporation. The construction of the variable requires detailed information on the loan portfolio of banks. We take this information from the AnaCredit dataset.[18] If available, we then use ratings of each debtor to compute the CQS. In the remaining cases, we use the default probabilities reported in the AnaCredit data to compute the CQS. In column (4) of Table 7 we find a larger treatment effect for banks with ex-ante riskier credit claims. The difference of the coefficients (Treated-High versus Treated-Low) is significant at the 5% level. A possible explanation for this result is that the modified ACC framework primarily aims at credit claims with lower credit quality and government-guaranteed loans, which are also extended to riskier firms (see, e.g. Jiménez et al., 2022). Therefore, the variable *Portfolio Risk* might capture the exposure of a bank to the ACC framework extension, which is why we see stronger effects for highly exposed banks.

4.2.4 Linking Collateral Pledging to Money Market Activity

As already explained above, one key advantage of our empirical analysis is the high level of granularity and complementarity of our dataset, giving us a holistic view on a bank's collateral pool (UCDB), its bond holdings (SHS-G), and its repo market activity (MMSR). In the subsequent analysis, we exploit these features and ask where the bonds that end up

[17] To assess the credit quality of eligible assets, the Eurosystem takes into account information - ratings or probabilities of default - from credit assessment systems belonging to one of three sources: (1) external credit ratings (ECAIs), (2) national central banks' in-house credit assessment systems (ICASs), and (3) counterparties' internal ratings-based (IRB) systems. See ECB webpage for more information.

[18] More information on the data can be found here. Details on the preparation of the dataset and the construction of the variable are available upon request.

in the private collateral market after the ACC framework extension are actually coming from. In principle, there are two options: A bank can actively take out assets from its collateral pool to subsequently lend them out in the repo market. In this case, we would expect the effect to be stronger for bonds which have been pledged as collateral prior to the ACC extension. Alternatively, a bank can use a larger part of its bond holdings for repo market lending, knowing that it no longer needs to retain as many bonds as potential collateral for central bank funding under the extended collateral framework. In this case, we would expect the effect to be stronger for bonds which are part of a bank's bond portfolio prior to the ACC extension.

To test both explanations, we modify our main regression equation (2) and interact the *Post* $\times$ *Treated* dummy with two additional variables. In Panel A of Table 8 we include the variable $D_{Pledged}$, which is a dummy variable that takes the value of 1 whenever the bond was pledged as collateral with the Eurosystem in the four weeks leading up to the ACC extension.[19] Moreover, we include the variable D_{Held} into the regression, which takes the value of 1 whenever the bond is held on the bank's balance sheet prior to the ACC extension, i.e. at the end of Q1/2020, and zero otherwise. For both *Net Lending* (column 1) and *Gross Lending* (column 2), we obtain a positive and statistically significant coefficient estimate for the triple interaction term with D_{Held} while the triple interaction with $D_{Pledged}$ remains insignificant. This is an interesting result because it shows that banks do not remove already encumbered assets from their collateral pools with the Eurosystem for their repo market lending. They rather lend out a larger part of their bond holdings once the extended ACC framework is in place. A more general implication of this finding is that the ownership structure of a bond even *within a certain group of investors* – in our case banks with versus without non-marketable collateral – matters for the availability of the bond in the repo market.

In Panel B we present very similar regressions with continuous versions of the two dummy variables. We include the variable *Amount Pledged*, which is the amount of a bond pledged by a bank as collateral for refinancing operations with the Eurosystem, scaled by the bond's amount outstanding and the variable *Amount Held* into the regression, which is the amount of a bond held by a bank on its asset side of the balance sheet, scaled by

[19] We choose the four-weeks window for two reasons: (1) Previously pledged bonds might not immediately be lend out in the repo market; (2) Taking a longer window gives us more variation for our regressions.

the bond's amount outstanding. Results are very similar as in Panel A in this case.

4.2.5 Bond-Level Analysis

In the final step, we document that the observed changes in the securities lending activities of treated banks following the ACC extension also have a material impact on the aggregate bond level. For this analysis, we collapse our MMSR data into a bond-week panel. Moreover, since treatment is so far defined at the bank-level, we need to construct a set of new variables which act as proxies for the treatment intensity of each bond. All else equal, these variables should reflect that bonds with higher ex-ante exposure to treated banks are more likely to be affected by the ACC extension given that these banks on average increase their repo lending relative to control banks. To measure a bond's exposure to treated banks, we use information regarding the holder structure of the bond and information regarding the intensity at which treated and control banks pledge the bond as collateral with the Eurosystem. To be more specific, $Frac_{Held}$ ($Frac_{Pledged}$) is defined as the amount of a bond held (pledged) by banks with non-zero mobilised non-marketable collateral, scaled by the total amount held (amount pledged) across all banks in the sample. Whether the effect is driven by ownership structure, i.e. $Frac_{Held}$, or pledging intensity, i.e. $Frac_{Pledged}$, is again a question of whether the treated banks source the bonds for their repo market activity from their collateral pool or from their bond portfolio. Importantly, each bond-level treatment variable is fixed before the ACC framework extention in April 2020 in order to reduce endogeneity issues.

Table 9 displays the results. Across all specifications, we include bank $\times$ bond and issuer $\times$ maturity $\times$ time fixed effects. Moreover, we include control variables related to both the bank and the bond dimension. As bank-level controls, we take the same set of bank characteristics as before but now calculate volume-weighted averages across banks. As bond-level controls, we include a dummy for the on-the-run status of a bond, and dummy variables to capture auctions and CTD bonds for futures delivery dates. Moreover, we include variables capturing the effect of central bank's asset purchase programs, both in terms of stock and flow.

In columns (1) and (2), we look at the net and gross securities lending volumes. We find that bonds that are held by a higher fraction of treated banks experience a significant increase in gross but not in net lending volumes relative to other bonds. Looking at column (2), for a one standard deviation increase in $Frac_{Held}$, gross lending increases by 1.17 (31.134 x 0.0376) percentage points, which corresponds to a 11% increase relative to the variable's standard deviation (1.17 / 10.73). Defining treatment intensity through pledging intensity ($Frac_{Pledged}$) yields an insignificant result. This highlights once more that the effect we document works through the bond portfolio of a bank: when deciding on which assets to retain for refinancing operations, banks factor in a broader collateral framework and use previously ineligible low-quality assets as collateral while lending out the remaining unencumbered high-quality bonds in the repo market. On the other hand, they do not retrieve those bonds that are already part of the collateral pool with the Eurosystem. In column (3), where gross borrowing is the dependent variable, we obtain a positive and significant coefficient estimate for the interaction between *Post* and $Frac_{Held}$, albeit the magnitude is smaller compared to the corresponding coefficient in column (2). This finding again rationalizes why the interaction term $Post \times Frac_{Held}$ is not significant for *Net Lending* in column (1). Repo and reverse repo volumes at the bond-level move in tandem and any increase in lending is matched by a comparable increase in borrowing.

Columns (4) and (5) then look at collateral reuse. We find a significantly positive effect on the reuse amount when treatment intensity is defined through asset holdings in Column (5). This implies that a bond held by a higher fraction of treated banks is reused to a larger extent, which can also increases the overall availability of safe assets in the repo market (Jank et al., 2022; Inhoffen & van Lelyveld, 2023), despite the insignificant increase in net lending that we observe. In column (6), where the specialness spread is the dependent variable, we obtain a negative and statistically significant coefficient estimate for the interaction between *Post* and $Frac_{Held}$. In economic terms, bonds which are predominantly held by treated banks experience a decrease in specialness by 0.5 basis points (for a one standard deviation increase in $Frac_{Held}$) relative to other bonds, which amounts to about 8% of the standard deviation of specialness. This is an important result as the specialness of a bond can be interpreted as a scarcity premium (Arrata et al., 2020; Corradin & Maddaloni, 2020). A decline in specialness is therefore a sign for lower levels of asset scarcity. Lastly, in column (7) we run a regression with the variable *Rate Dispersion*, which Duffie & Krishnamurthy (2016) define as the volume-weighted absolute deviation of rates from average rates in a given week as dependent variable. Again, we obtain a negative and statistically significant coefficient estimate for the interaction of $Post$ with $Frac_{Held}$. All in all, a broader collateral framework can thus help to improve repo market functioning by increasing the availability of high-quality assets for private market transactions. Affected banks scale up their securities lending activities which ultimately leads to higher reuse of bonds and a concomitant compression of scarcity premia and rate dispersion.

5 Conclusion

This paper provides empirical evidence on how central bank collateral policies can affect repo markets. It documents that a shift towards a broader set of eligible collateral can promote market functioning to the extent that it increases the amount of high-quality collateral available to the market. This empirical evidence is in line with the theory presented by Choi et al. (2021). Our findings suggest that banks affected by a temporary extension of the collateral set pledge newly eligible credit claims instead of government bonds. Banks then lend out these unencumbered high-quality bonds as collateral in the repo market, which helps to alleviate asset scarcity.

The overarching goal of a collateral framework of a central bank is to balance the smooth conduct of monetary policy on the one hand and an adequate protection of the central bank balance sheet against potential losses on the other hand. Recent evidence shows that asset scarcity can negatively affect the transmission of monetary policy by delaying the pass-through of policy rates to the repo market. Taking our findings on how collateral easing can address such scarcity, one could thus argue that a broader collateral framework might in turn be beneficial for a smooth monetary policy transmission.

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Figures and Tables

Figure 1: Securities lent by the Eurosystem

This figure shows the total amount of collateral (by asset type) mobilised for refinancing operations with the Eurosystem from 2014 until 2022 Q2. The blue line depicts the average amount of credit outstanding, whereas the red points represent peak outstanding credit. Source: https://www.ecb.europa.eu/paym/coll/charts/html/index.en.html

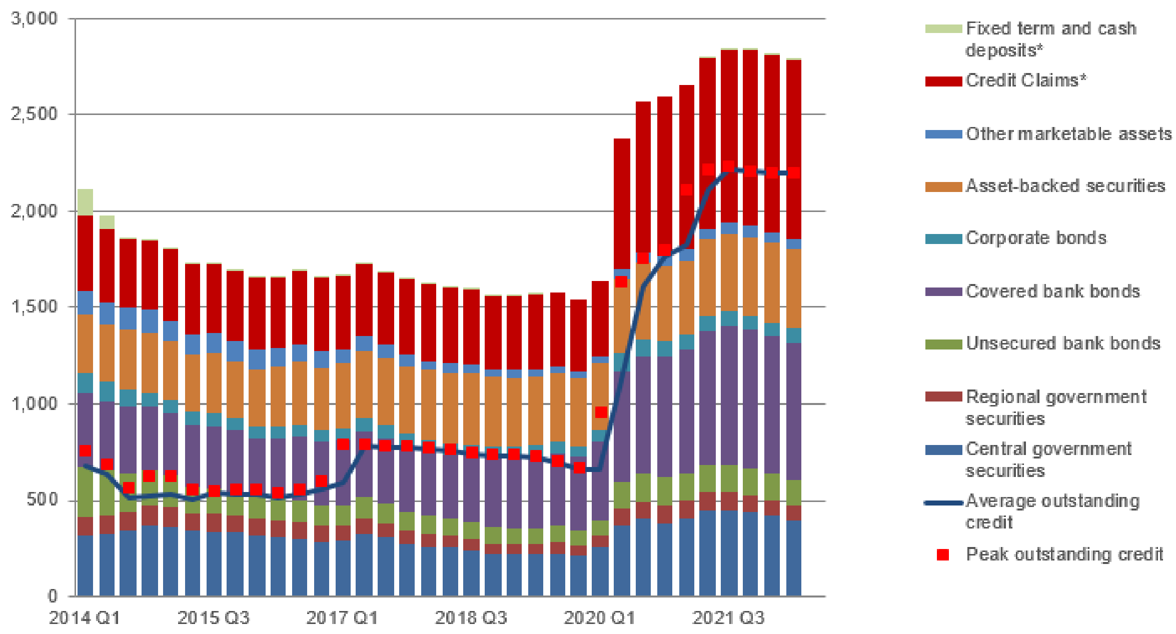


Figure 2: Pledged Collateral - Identification
This figure shows the evolution of collateral mobilised for refinancing operations with the Eurosystem for 2019 and 2020. The solid red line depicts the evolution of the collateral pool of treated banks, i.e. banks that have credits claims pledged as collateral prior to the ACC extension. The solid blue line depicts the evolution of the collateral pool of banks belonging to the control group, i.e. banks that only have marketable assets pledged as collateral prior to the ACC extension. Both lines are indexed to have a value of one at the end of March 2020. The dashed green line depicts the share of marketable assets in the collateral pool of treated banks (right scale). The dashed yellow line depicts the share of additional credit claims in the collateral pool of treated banks (right scale). The black vertical line marks the time of the extension of the ACC framework.

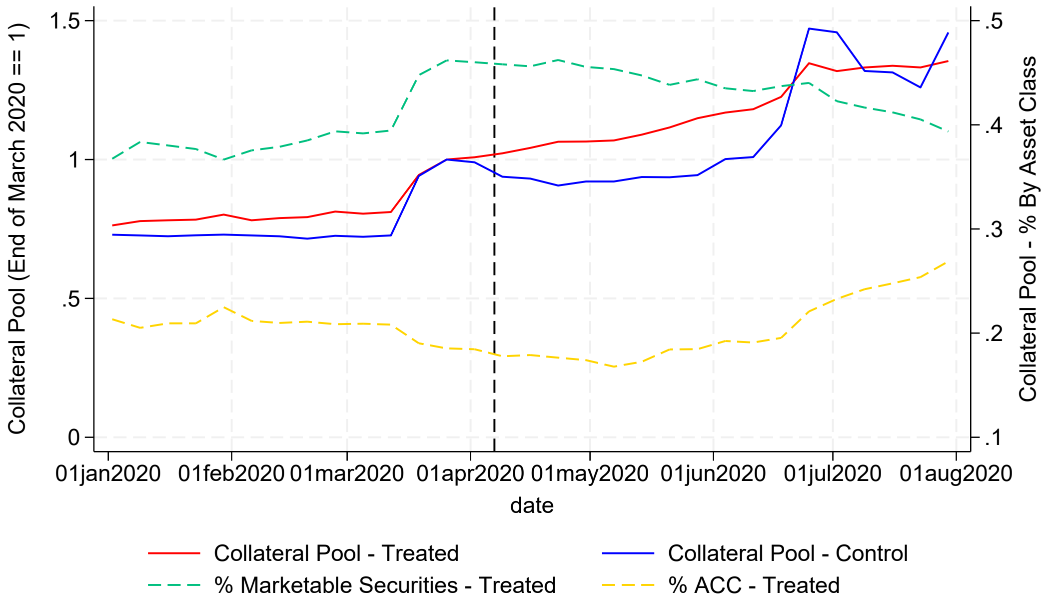
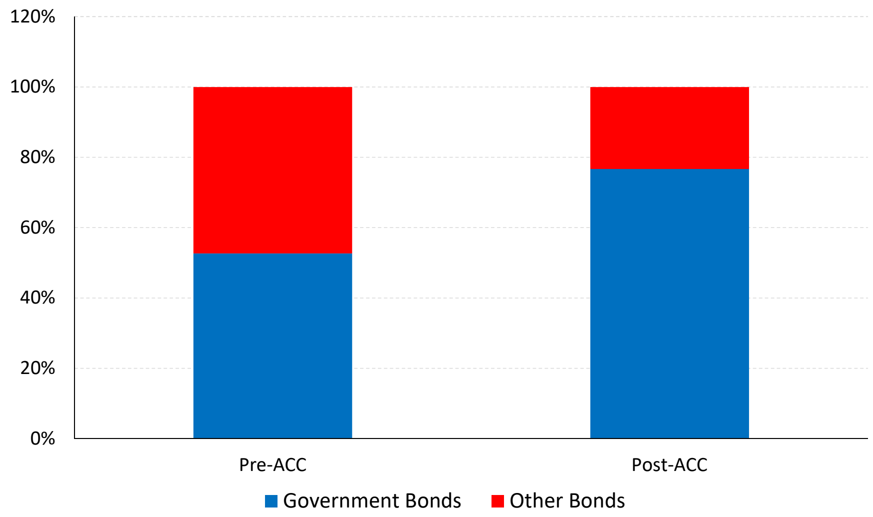


Figure 3: Pledged Collateral - Difference-in-Difference
This figure shows the type of collateral banks use for refinancing operations of the Eurosystem. As our starting point, we take the total increase in collateral pledged for refinancing operations in the six months before and after the extension of the ACC framework on April 7, 2020, respectively. Each bar then gives a decomposition of these refinancing operations into different types of pledged collateral. We distinguish between four types of assets: government bonds, other marketable bonds, regular credit claims (RCC), and additional credit claims (ACC). The upper graph shows the collateral posted by banks without non-marketable assets (credit claims). The lower graph shows the collateral posted by banks with non-marketable assets.

(a) Banks without Non-Marketable Assets (Control Group)



(b) Banks with Non-Marketable Assets (Treatment Group)

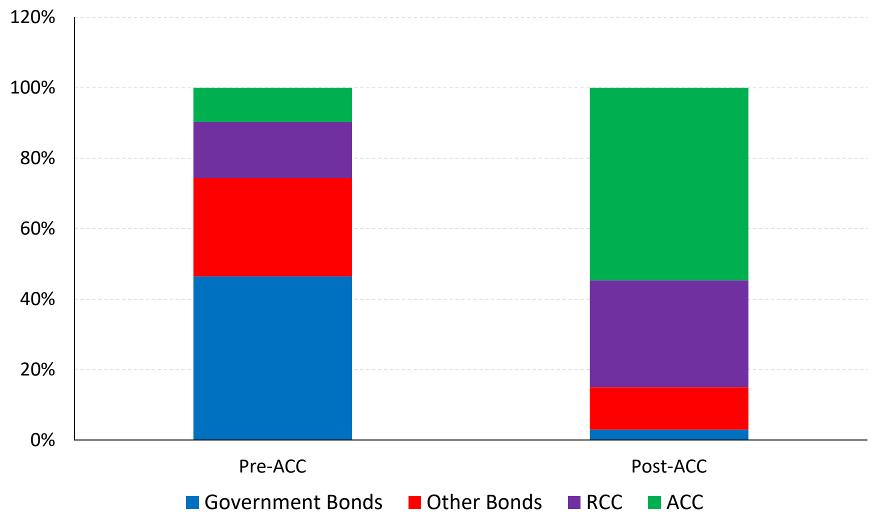


Figure 4: Coefficient Plot - Net Lending

Figure 4 shows the results for estimating the regression equation (2), where March 2020 serves as the baseline effect. The dependent variable is the net lending volume. We plot the dynamic coefficient on the treatment dummy with 95% confidence bands

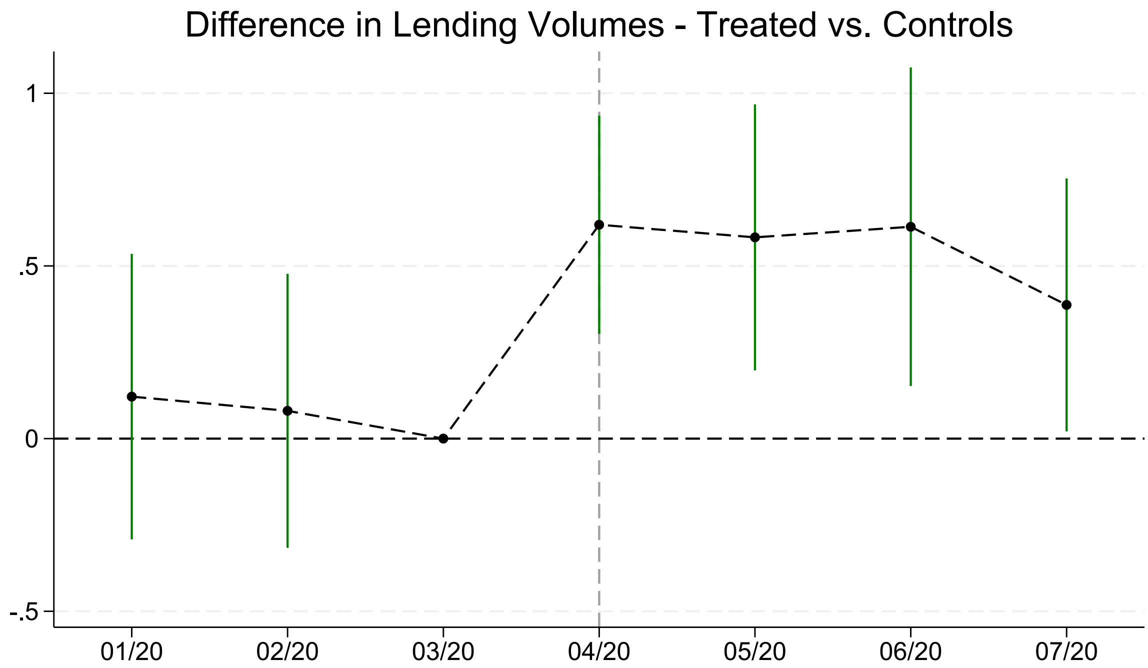


Table 1: Summary Statistics - Bank level

Table 1 shows summary statistics for the bank level variables used in the analysis. 'Treated' is a dummy variable that equals 1 for banks which have non-zero mobilised non-marketable collateral as of the end of March 2020. 'log(total assets)' is the natural logarithm of a banks total assets. 'Equity ratio' denotes the ratio of a bank's equity over total assets. 'NFC Loans ratio' are all loans to non-financial corporations over total assets. 'Bonds held ratio' is the ratio of all bonds that a bank holds over total assets. 'Reserves ratio' is the ratio of banks' central bank reserves over total assets. 'LTRO ratio' is the amount of longer term refinancing operations (incl. TLTROs) over total assets. The table is based on data from March 2020, i.e. before the introduction of the ACC program. Panel A shows summary statistics for the UCDB sample and Panel B contains summary statistics for the MMSR sample.

Panel A: UCDB Sample

	Treated = 0				Treated = 1			
	Mean	Std. Dev.	Median	Obs.	Mean	Std. Dev.	Median	Obs.
log(total assets)	10.462	0.897	10.482	42	11.424	1.087	11.25	87
Equity ratio (in %)	8.342	4.062	7.668	42	7.771	3.497	7.442	87
NFC Loans ratio (in %)	9.847	11.375	7.538	42	19.614	12.193	19.634	87
Bonds held ratio (in %)	9.589	8.152	7.701	42	9.138	5.536	8.603	87
Reserves ratio (in %)	9.271	8.933	5.864	42	5.986	4.491	5.079	87
LTRO ratio (in %)	1.194	2.78	0.000	42	3.583	3.214	2.439	87

Panel B: MMSR Sample

	Treated = 0				Treated = 1			
	Mean	Std. Dev.	Median	Obs.	Mean	Std. Dev.	Median	Obs.
log(total assets)	13.109	0.049	13.099	5	13.067	0.080	13.095	32
Equity ratio (in %)	5.290	0.164	5.340	5	5.578	0.527	5.513	32
NFC Loans ratio (in %)	8.605	0.304	8.571	5	9.032	0.846	8.780	32
Bonds held ratio (in %)	4.706	0.781	4.580	5	5.154	1.100	4.833	32
Reserves ratio (in %)	3.836	0.288	3.821	5	3.639	0.367	3.734	32
LTRO ratio (in %)	0.568	0.080	0.543	5	0.640	0.251	0.596	32

Table 2: Summary Statistics - Securities Lending

Table 2 shows summary statistics for the main variables used in the empirical analysis. Panel A displays summary statistics for the sample used in Section 4.2.2 at the bank-bond level. Panel B displays summary statistics for the sample used in Section 4.2.5. The variables 'Gross Securities Lending Volume' and 'Gross Securities Borrowing Volume' denote the security lending (borrowing) volume scaled by a bond's amount outstanding (in %), respectively. 'Net Securities Lending Volume' denotes the security lending volume net of the security borrowing volume scaled by a bond's amount outstanding (in %). 'Specialness Spread' is the volume-weighted rate of all securities lending transaction on a given day (in basis points) net of the GC pooling rate. 'Reuse Amount' is the amount of reused collateral (as defined in Jank et al. (2022)) scaled by a bond's amount outstanding (in %). 'Reuse Rate' is the amount of reused collateral scaled by incoming collateral (in %). 'Rate Volatility' is the standard deviation of deal rates. 'Rate Dispersion' is the volume-weighted absolute deviation of rates from the average rate (as in Duffie & Krishnamurthy (2016)). 'Post' is a dummy variable that equals 1 for the time period after the extension of the ACC program on April 7, 2020 and zero otherwise and 'Treated' is a dummy variable that equals 1 for banks which have non-zero mobilised non-marketable collateral as of the end of March 2020. 'Pledged' and 'Held' is the fraction of a bond's overall amount pledged (held) that comes from treated banks, respectively. The sample period is January to July 2020.

Panel A: Bank-Bond Level

	Mean	Std. Dev.	Median	Obs.
Post	0.577	0.494	1.000	132,810
Treated	0.878	0.328	1.000	132,810
Gross Securities Lending Volume	1.138	2.735	0.145	132,810
Gross Securities Borrowing Volume	1.036	2.755	0.121	132,810
Net Securities Lending Volume	0.102	4.028	0.008	132,810
Specialness Spread	2.560	7.262	1.600	85,782
Reuse Amount	0.300	0.984	0.000	132,810
Reuse Rate	16.516	34.326	0.000	132,810

Panel B: Bond Level

	Mean	Std. Dev.	Median	Obs.
Post	0.580	0.494	1.000	11,128
Pledged	47.968	48.438	31.103	11,128
Held	53.592	31.135	48.447	11,128
Gross Securities Lending Volume	12.342	10.462	9.489	11,128
Gross Securities Borrowing Volume	10.619	10.73	7.48	11,128
Net Securities Lending Volume	1.723	10.225	1.504	11,128
Specialness Spread	1.983	6.184	1.254	11,128
Reuse Amount	7.285	7.931	4.76	11,128
Reuse Rate	53.592	31.135	48.447	11,128
Rate Volatility	2.736	2.48	1.901	11,128
Rate Dispersion	11.035	27.335	2.723	11,128

Table 3: Pledged Collateral - Difference-in-Difference Regressions

Table 3 shows the result for the fixed-effects panel regression, where the dependent variable is the weekly nominal value of marketable securities (bonds) pledged by banks as part of their collateral pool with the Eurosystem scaled by the bond's amount outstanding. The main explanatory variables are: *Post*, which is a dummy variable that equals 1 for the time period after the extension of the ACC program on April 7, 2020 and zero otherwise; *Treated*, which is a dummy variable that equals 1 for banks which have non-zero mobilised non-marketable collateral as of the end of March 2020; *Government*, which is a dummy variable that equals 1 for bonds issued by central governments. The sample period is January 2020 to July 2020. We exclude banks with less than EUR 10 billion of total assets over the sample period. We report t-statistics based on standard errors clustered at the bank and time level, in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Dependent variable:	Nominal Value Pledged scaled by Amount Outstanding			
	(1)	(2)	(3)	(4)
	All bonds	Other bonds	Government	All bonds
Post x Treated	0.0090	0.0665	-0.1188**	0.0674
	(0.15)	(1.85)	(-2.49)	(0.84)
Post x Treated x Government				-0.1992**
				(-2.22)
Adj. R2	.8673	.8633	.8585	.8673
Obs	682,937	500,902	182,035	682,937
Bank-level Controls	Yes	Yes	Yes	Yes
Bond x Time FE	Yes	Yes	Yes	Yes
Bank x Bond FE	Yes	Yes	Yes	Yes
Clustered S.E.	Bank, Time	Bank, Time	Bank, Time	Bank, Time

Table 4: Pledged Government Bonds & Money Market Conditions

Table 4 shows the result for the fixed-effects panel regression, where the dependent variable is the weekly nominal value of marketable securities (bonds) pledged by banks as part of their collateral pool with the Eurosystem scaled by the bond's amount outstanding. The main explanatory variables are: *Post*, which is a dummy variable that equals 1 for the time period after the extension of the ACC program on April 7, 2020 and zero otherwise and *Treated*, which is a dummy variable that equals 1 for banks which have non-zero mobilised non-marketable collateral as of the end of March 2020. We interact these variables with *Gross Lending*, which is the previous week's securities lending volume of the bond; *Net Lending*, which is the previous week's securities lending volume (net of borrowing) of the bond; *Specialness*, which is the previous week's specialness spread; $Specialness_{\perp}$, which is the previous week's specialness spread, orthogonalized with respect to a bond's rating, time to maturity, amount outstanding, on-the-run status, cheapest-to-delivery status and auction cycle. The sample period is January 2020 to July 2020. We only consider government bonds pledged as collateral. We exclude banks with less than EUR 10 billion of total assets over the sample period. We report t-statistics based on standard errors clustered at the bank and time level, in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Dependent variable:	Nominal Value Pledged scaled by Amount Outstanding			
	(1)	(2)	(3)	(4)
Post x Treated	-0.1113**	-0.1074**	-0.1106**	-0.1137**
	(-2.24)	(-2.13)	(-2.24)	(-2.31)
Post x Treated x Gross Lending	-0.0290			
	(-1.43)			
Post x Treated x Net Lending		-0.0312		
		(-1.25)		
Post x Treated x Specialness			-0.1088**	
			(-2.10)	
Post x Treated x $Specialness_{\perp}$				-0.1026*
				(-1.96)
Adj. R2	.7764	.7764	.7768	.7768
Obs	114,044	114,044	114,044	114,044
Bank-level Controls	Yes	Yes	Yes	Yes
Bond x Time FE	Yes	Yes	Yes	Yes
Bank x Bond FE	Yes	Yes	Yes	Yes
Clustered S.E.	Bank, Time	Bank, Time	Bank, Time	Bank, Time

Table 5: Collateral Pledging and Money Market Activity - Simple Test

Table 5 shows the result for the fixed-effects panel regression, where the dependent variables are: net securities lending volume in column (1), gross securities lending volume in column (2), gross securities borrowing volume in column (3), the reuse rate in column (4), the reuse amount in column (5), and the volume-weighted lending rate (net of the GC rate) in column (6). The main explanatory variables are *Collateral Pledged* , which is the amount of a security pledged with the Eurosystem scaled by a bond's amount outstanding and lagged by one period. In Panel B, we include the following bank-level variables as controls: log of total assets, equity ratio, corporate loan ratio, bonds ratio, reserve ratio and borrowing in LTROs or TLTROs scaled by total assets. We further include on the bond-level dummy variables for on-the-run status, for auction periods and the cheapest-to-deliver (CTD) in Futures contracts and variables related to stock and flow of the central bank's asset purchase programs. Fixed effects are included as shown at the bottom of the table. The sample period is January 2020 to July 2020. The frequency of the data is weekly. The sample includes 37 banks as described in Section 3.4. In Panel A, we report t-statistics based on double-clustered standard errors at the bank and time level, in parentheses. In Panel B, we report t-statistics based on double-clustered standard errors at the bond and time level. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Panel A: Bank-Bond-Level

Dependent variable:	Net Lending	Gross Lending	Gross Borrowing	Reuse Rate	Reuse Amount	Specialness
	(1)	(2)	(3)	(4)	(5)	(6)
Collateral Pledged	-0.1628***	-0.1203***	0.0426	-0.2045	0.0019	0.0091
	(-2.96)	(-3.46)	(1.38)	(-0.87)	(0.21)	(0.71)
Adj. R2	.4313	.4628	.4836	.2229	.2676	.7342
Obs	132,754	132,754	132,754	132,754	132,754	85,035
Bond x Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank x Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank x Bond FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered S.E.	Bank, Time	Bank, Time	Bank, Time	Bank, Time	Bank, Time	Bank, Time

Panel B: Bond-Level

Dependent variable:	Net Lending	Gross Lending	Gross Borrowing	Reuse Rate	Reuse Amount	Specialness
	(1)	(2)	(3)	(4)	(5)	(6)
Collateral Pledged	-0.1871	-0.8237***	-0.6366**	-1.2534*	-0.2997*	0.0512
	(-0.88)	(-3.43)	(-2.68)	(-1.70)	(-1.74)	(0.63)
Adj. R2	.5107	.63	.6465	.5673	.6326	.5347
Obs	11,989	11,989	11,989	11,989	11,989	11,989
Bank x Bond FE	Yes	Yes	Yes	Yes	Yes	Yes
Issuer x Maturity x Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered S.E.	Bond, Time	Bond, Time	Bond, Time	Bond, Time	Bond, Time	Bond, Time

Table 6: DiD - Money Market Activity

Table 6 shows the result for the fixed-effects panel regression. In column (1) the dependent variable is the net securities lending volume (defined as gross lending - borrowing) of bank b in bond i on week t, scaled by bond i's amount outstanding. In column (2) the dependent variable is the gross securities lending volume of bank b in bond i on week t, scaled by bond b's amount outstanding. In column (3), the dependent variable is the gross securities borrowing amount. The dependent variable is the reuse rate in column (4) and the reuse amount in column (5). In column (6) the dependent variable is the volume-weighted deal rate across all lending transactions of bank b in bond i on week t (net of the GC rate). The main explanatory variables are: *Post*, which is a dummy variable that equals 1 for the time period after the extension of the ACC program on April 7, 2020 and zero otherwise and *Treated*, which is a dummy variable that equals 1 for banks which have non-zero mobilised non-marketable collateral as of the end of March 2020. The sample period is January 2020 to July 2020. The frequency of the data is weekly. The sample includes 37 banks as described in Section 3.4. Fixed effects are included as shown at the bottom of the table. We report t-statistics based on standard errors clustered at the bank and time level, in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Dependent variable:	Net Lending	Gross Lending	Gross Borrowing	Reuse Rate	Reuse Amount	Lending Rate
	(1)	(2)	(3)	(4)	(5)	(6)
Post x Treated	0.5015**	0.4107***	-0.0908	1.3978	-0.0197	-0.2306
	(2.64)	(3.03)	(-0.66)	(1.09)	(-0.49)	(-0.94)
Adj. R2	.4223	.4562	.472	.2184	.2637	.7205
Obs	132,810	132,810	132,810	132,810	132,810	85,094
Bank-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bond x Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank x Bond FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered S.E.	Bank, Time	Bank, Time	Bank, Time	Bank, Time	Bank, Time	Bank, Time

Table 7: DiD - Money Market Activity - Heterogeneities

Table 6 shows additional result for the fixed-effects panel regression, where the dependent variable is the net securities lending volume (defined as gross lending - borrowing) of bank b in bond i on week t, scaled by bond i's amount outstanding. The main explanatory variables are: *Post*, which is a dummy variable that equals 1 for the time period after the extension of the ACC program on April 7, 2020 and zero otherwise and *Treated*, which is a dummy variable that equals 1 for banks which have non-zero mobilised non-marketable collateral as of the end of March 2020. The variable *Treated* is further split according to the median of the variable *Overcollateralization* (columns 1), *Collateral Constraint* (column 2), *Share Credit Claims* (column 3) and *Portfolio Risk* (column 4). We report the difference in the coefficients between *Post x Treated-High* and *Post x Treated-Low* and the t-value of a significance test of this difference. The sample period is January 2020 to July 2020. The frequency of the data is weekly. The sample includes 37 banks as described in Section 3.4. Fixed effects are included as shown at the bottom of the table. We report t-statistics based on standard errors clustered at the bank and time level, in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Dependent variable:	Net Lending scaled by Amount Outstanding			
	Overcollateralization	Collateral Constraint	Credit Claim Share	Portfolio Risk
	(1)	(2)	(3)	(4)
Post x Treated-High	0.6031***	0.3765*	0.5104***	0.6770***
	(3.04)	(1.72)	(3.16)	(2.81)
Post x Treated-Low	0.3578*	0.5694***	0.4967**	0.2605
	(1.76)	(2.91)	(2.28)	(1.35)
Adj. R2	.4225	.4224	.4223	.4227
Obs	132,810	132,810	132,810	132,810
Difference	0.2453*	-0.1929	0.0137	0.4165**
	(1.98)	(-1.51)	(0.11)	(2.30)
Bank-level Controls	Yes	Yes	Yes	Yes
Bond x Time FE	Yes	Yes	Yes	Yes
Bank x Bond FE	Yes	Yes	Yes	Yes
Clustered S.E.	Bank, Time	Bank, Time	Bank, Time	Bank, Time

Table 8: DiD - Linking Collateral Pledging to Money Market Activity

Table 8 shows the result for the fixed-effects panel regression at the bank level. In column (1) the dependent variable is the net securities lending volume (defined as gross lending - borrowing) of bank b in bond i on week t, scaled by bond i's amount outstanding. In column (2) the dependent variable is the gross securities lending volume of bank b in bond i on week t, scaled by bond i's amount outstanding. In column (3) the dependent variable is the gross securities borrowing amount. The main explanatory variables are: *Post*, which is a dummy variable that equals 1 for the time period after the extension of the ACC program on April 7, 2020 and zero otherwise, and *Treated*, which is a dummy variable that equals 1 for banks which have non-zero mobilised non-marketable collateral as of the end of March 2020. In Panel A the explanatory variables of interest are $D_{Pledged}$ and D_{Held}, which are dummy variables that take the value of 1 whenever the bond was pledged as collateral with the Eurosystem (held on the bank's balance sheet) prior to the ACC extension, respectively. In Panel B the explanatory variables of interest are *Amount Pledged* and *Amount Held*, which is the amount of bond i pledged by bank b as collateral for refinancing operations with the Eurosystem (held on its banlance sheet) prior to the ACC, respectively, scaled by the bond's amount outstanding. The sample period is January 2020 to July 2020. The frequency of the data is weekly. Fixed effects are included as shown at the bottom of the table. We report t-statistics based on standard errors clustered at the bank and time level, in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Panel A: Dummy

Dependent variable:	Net Lending	Gross Lending	Gross Borrowing
	(1)	(2)	(3)
Post x Treated	0.0872	0.0254	-0.0618
	(0.51)	(0.24)	(-0.43)
Post x $D_{Pledged}$	-0.2926	-0.0693	0.2233
	(-1.05)	(-0.33)	(1.14)
Post x Treated x $D_{Pledged}$	0.3466	0.0877	-0.2589
	(0.76)	(0.23)	(-1.27)
Post x Dummy: D_{Held}	-1.0915***	-0.9966***	0.0949
	(-9.14)	(-8.60)	(1.30)
Post x Treated x D_{Held}	0.8946***	0.8500***	-0.0446
	(6.10)	(7.74)	(-0.43)
Adj. R2	.4218	.4559	.4718
Obs	132,810	132,810	132,810
Bank-level Controls	Yes	Yes	Yes
Bond x Time FE	Yes	Yes	Yes
Bank x Bond FE	Yes	Yes	Yes
Clustered S.E.	Bank, Time	Bank, Time	Bank, Time

Panel B: Amount (% Outstanding)

Dependent variable:	Net Lending	Gross Lending	Gross Borrowing
	(1)	(2)	(3)
Post x Treated	0.3115*	0.2240*	-0.0875
	(1.75)	(1.83)	(-0.61)
Post x Amount Pledged	-0.4054	-0.2183	0.1871
	(-1.49)	(-0.94)	(1.16)
Post x Treated x Amount Pledged	0.4275	0.2286	-0.1989
	(1.42)	(0.89)	(-1.20)
Post x Amount Held	-1.1403***	-1.1309***	0.0093
	(-9.95)	(-10.07)	(0.25)
Post x Treated x Amount Held	1.0312***	1.0169***	-0.0144
	(7.75)	(8.47)	(-0.29)
Adj. R2	.4595	.4559	.4718
Obs	132,810	132,810	132,810
Bank-level Controls	Yes	Yes	Yes
Bond x Time FE	Yes	Yes	Yes
Bank x Bond FE	Yes	Yes	Yes
Clustered S.E.	Bank, Time	Bank, Time	Bank, Time

Table 9: DiD - Bond-Level Analysis

Table 9 shows the result for a fixed-effects panel regression at the bond level, where the dependent variables are: net securities lending volume in column (1), gross securities lending volume in column (2), securities borrowing volume in column (3), the reuse rate in column (4), the reuse amount in column (5), the specialness (lending rate net of the GC rate) in columns (6), and the rate dispersion in column (7), of bond i in week t, respectively. The main explanatory variables are: *Post*, which is a dummy variable that equals 1 for the time period after the extension of the ACC program on April 7, 2020 and zero otherwise; $Frac_{Held}$, which is the pre-ACC amount of bond i held by banks which have non-zero mobilised non-marketable collateral scaled by the holdings of all sample banks; and $Frac_{Pledged}$, which is the pre-ACC amount of bond i pledged by banks which have non-zero mobilised non-marketable collateral scaled by the bond's total collateral value pledged by all sample banks. The sample period is January 2020 to July 2020. The frequency of the data is weekly. The sample includes 37 banks as described in Section 3.4. We report t-statistics based on standard errors clustered at the bond and time level, in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Dependent variable:	Net Lending	Gross Lending	Gross Borrowing	Reuse Rate	Reuse Amount	Specialness	Rate Dispersion
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post x $\text{Frac}_{\text{Pledged}}$	0.0114	0.0029	-0.0085	0.0353	0.0058	-0.0013	0.0149
	(1.54)	(0.38)	(-1.35)	(1.61)	(1.02)	(-0.43)	(1.10)
Post x $\text{Frac}_{\text{Held}}$	0.0117	0.0376***	0.0259*	0.0360	0.0236**	-0.0159**	-0.0413**
	(0.74)	(2.78)	(2.04)	(1.14)	(2.26)	(-2.55)	(-2.43)
Adj. R2	.4996	.6285	.6374	.5688	.6334	.5426	.4400
Obs	11,128	11,128	11,128	11,128	11,128	11,128	11,128
Bank x Bond FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer x Maturity x Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered S.E.	Bond, Time	Bond, Time	Bond, Time	Bond, Time	Bond, Time	Bond, Time	Bond, Time

Internet Appendix

A Additional Figures and Tables

Figure IA.1: Coefficient Plot - Gross Lending

Figure IA.1 shows the results for estimating the regression equation (2), where March 2020 serves as the baseline effect. The dependent variable is the gross lending volume. We plot the dynamic coefficient on the treatment dummy with 95% confidence bands

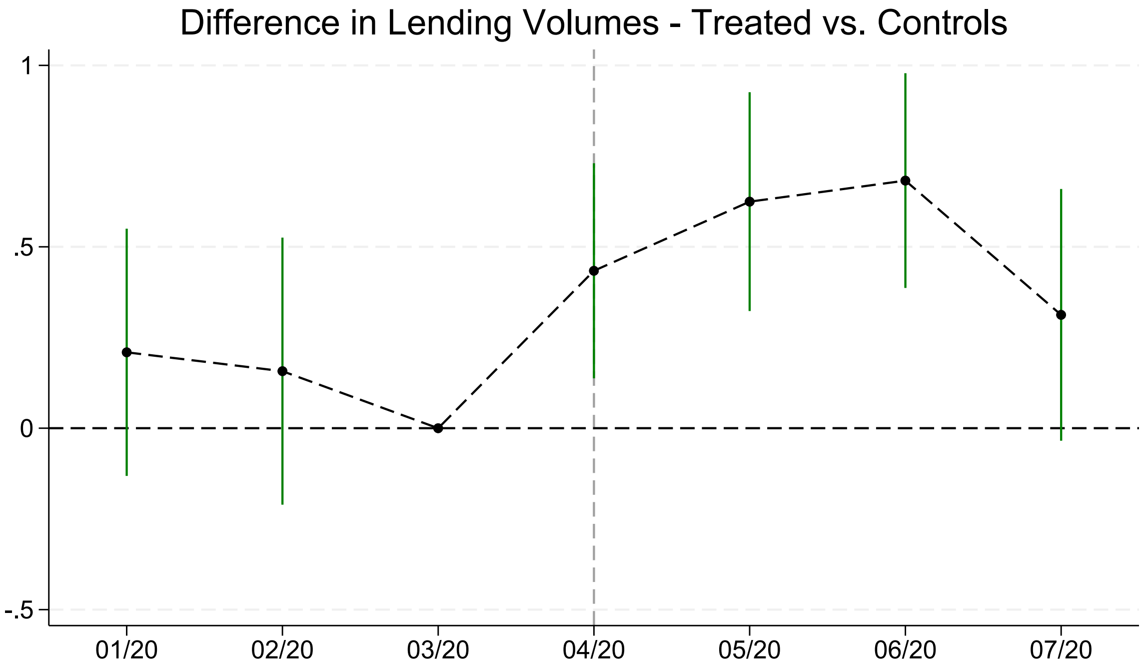


Figure IA.2: Coefficient Plot - Pledged Government Bonds

Figure IA.2 shows the results for estimating the regression equation (1), where March 2020 serves as the baseline effect. The dependent variable is the nominal amount of a bond pledged by a bank scaled with the bonds outstanding amount. We plot the dynamic coefficient on the treatment dummy with 95% confidence bands

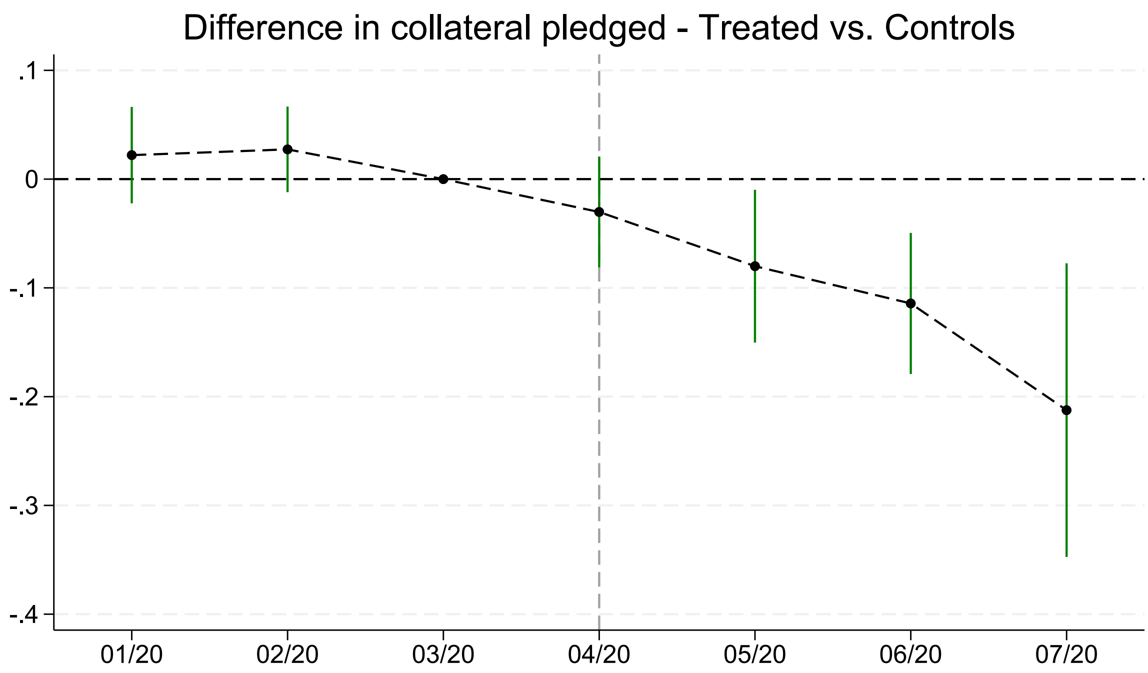


Table IA.1: Differences in Observables

Table IA.1 shows mean differences of treated and control banks for the summary statistics presented in Table 1. The table also reports the t-value of significance of the differences of means. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively. The table is based on data from March 2020, i.e. before the introduction of the ACC program.

	Mean (Treated=0)	Mean (Treated=1)	Difference	t-value
log(total assets)	13.109	13.067	0.042	1.128
Equity ratio (in %)	5.290	5.578	-0.289	-1.203
Cust. Loans ratio (in %)	8.605	9.032	-0.427	-1.106
Bonds held ratio (in %)	4.706	5.154	-0.448	-0.872
Reserves ratio (in %)	3.836	3.639	0.197	1.142
Ltro ratio (in %)	0.568	0.640	-0.071	-0.624

Table IA.2: Pledged Collateral - Difference-in-Difference Regressions (MMSR Banks)

Table IA.2 shows the result for the fixed-effects panel regression, where the dependent variable is the weekly nominal value of marketable securities (bonds) pledged by banks as part of their collateral pool with the Eurosystem scaled by the bond's amount outstanding. The main explanatory variables are: *Post*, which is a dummy variable that equals 1 for the time period after the extension of the ACC program on April 7, 2020 and zero otherwise; *Treated*, which is a dummy variable that equals 1 for banks which have non-zero mobilised non-marketable collateral as of the end of March 2020; *Government*, which is a dummy variable that equals 1 for bonds issued by central governments. The sample period is January 2020 to July 2020. We restrict the sample to banks which are reporting agents in the MMSR dataset. We report t-statistics based on standard errors clustered at the bank and time level, in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

Dependent variable:	Nominal Value Pledged scaled by Amount Outstanding			
	(1)	(2)	(3)	(4)
	All bonds	Other bonds	Government	All bonds
Post x Treated	-0.0832	0.0270	-0.3030***	-0.0022
	(-0.75)	(0.23)	(3.76)	(-0.02)
Post x Treated x Government				-0.2543***
				(-2.78)
Adj. R2	.8248	.8223	.7246	.8248
Obs	416,476	304,580	111,896	416,746
Bank-level Controls	Yes	Yes	Yes	Yes
Bond x Time FE	Yes	Yes	Yes	Yes
Bank x Bond FE	Yes	Yes	Yes	Yes
Clustered S.E.	Bank, Time	Bank, Time	Bank, Time	Bank, Time