# WORKING paper

BANQUE DE FRANCE

EUROSYSTÈME

# Eurosystem's asset purchases and money market rates

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## ABSTRACT

Some Euro area money market rates have been standing below the deposit facility rate since 2015, which coincided with the start of the Eurosystem's public sector purchase program (PSPP). In this paper, we explore empirically the interactions between the PSPP and short term secured money market rates (repo rates). We document different channels through which asset purchases may affect the various segments of the Euro area repo market. Using proprietary data from the PSPP purchases and transactions made on the repo market for specific securities ("special"), our results show that the PSPP has contributed to push down repo rate, in particular prior to January 2017. On average, purchasing 1% of a bond outstanding is associated with a decline in its repo rate of -0.78 bps.

Keywords: specialness, repo market, asset purchases, money market

JEL classification: E52 ; E58 ; G10

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# NON-TECHNICAL SUMMARY

Money market rates dropped to historically low levels in most economies, and in some countries trade below zero. In the Euro area, this is the case for both unsecured and secured money market rates. Repo market– in which transactions are secured by collateral – is crucially important for the Euro area financial system, as it represents by far the most active segment of interbank activity.

Repo rates particularly gained attention as they not only dropped below zero but also in some countries below the ECB deposit facility rate (DFR). At this rate, the ECB is paying interest rate on excess reserves, in principle deterring any market participant (with access to this facility) to lend liquidity below.

This deviation of repo rates almost coincided with the start of the large-scale purchases of sovereign bonds by the Eurosystem in 2015 (PSPP, Public Sector Purchases Program), and is often associated with distortions that would have be created by the program. The resulting dispersion of money market rates, as shown in the graph below, may reduce the monetary policy pass-through to short term rates, i.e. reduce the traction of the central bank operational tools to transmit the monetary policy stance.

In this paper, we try to assess the channels through which PSPP might have contributed to lowering repo rates. In particular, aggregate effects (such as excess liquidity, counterpart of the purchases) may coexist with individual-bond effects related to scarcity affecting bonds purchased by the PSPP. To disentangle these two channels, we distinguish two repo market segments, the GC (« General Collateral ») secured by an undetermined bond from a basket, and the SC (« Specific Collateral ») secured by an individual predetermined bond. The first is a priori a liquidity-driven market, while the latter is said to be « collateral-driven », as it is typically the market in which market participants borrow specific bonds, and thus in a sense price the bonds' scarcity.

Using trade-by-trade data from the most used repo platform in the Euro area and proprietary data on individual bond purchases by the Eurosystem, we first document the distribution of GC and SC rates in each of the seven largest jurisdictions of the Euro area. Second, we run a panel regression analysis to determine whether PSPP purchases are associated with lower repo rates between January 2015 and May 2017.

Our results suggest that PSPP has indeed two distinct types of effects on repo rates. The first one is related to aggregate effects of the programme, such as the increase in excess liquidity in the hands of market participants. We show that depending on countries, the relationship between excess liquidity and GC repo rates may vary, and in any case excess liquidity has more impact on core countries GC repo rates than peripherals. The second one is linked to the individual bond scarcity, as for bonds purchased, PSPP withdraws part of the outstanding from the market and thus limits the quantity available for lending in the repo market. Incidentally, we show that GC rates reflect the cost of borrowing the less valuable bonds in the SC market, so that in a jurisdiction where all bonds trade on special, GC cannot be seen as a pure risk-free rate anymore.

Other determinants are at play in the repo rates dynamics. Interestingly, end of periods (month, quarter) are associated with increased pressure on repo rates, which can be linked to regulatory reporting dates. Indeed, regulation may affect the repo market through different types of effects: regulatory demand of high quality assets that would not be available for lending in the repo market ; balance sheet costs penalizing repo transactions as they have an impact on the balance sheet size, etc.

In any case, central banks have instruments that may be fine-tuned to alleviate pressure in the repo market, if needed. We find that the period of implementation of the Security

Lending Facility (SLF) through which market participants can borrow limited amounts of securities purchased by the Eurosystem under the PSPP against cash (since 15th Dec 2016) is associated, on average, with lower pressure on repo rates.

Finally, our study shed light on the possibility that central bank purchases are accommodated by short sales and covered in the repo market in the first place, contributing to a better understanding of the mechanisms behind asset purchases programs.



Source: Arrata, Nguyen, Rahmouni-Rousseau and Vari (2017)
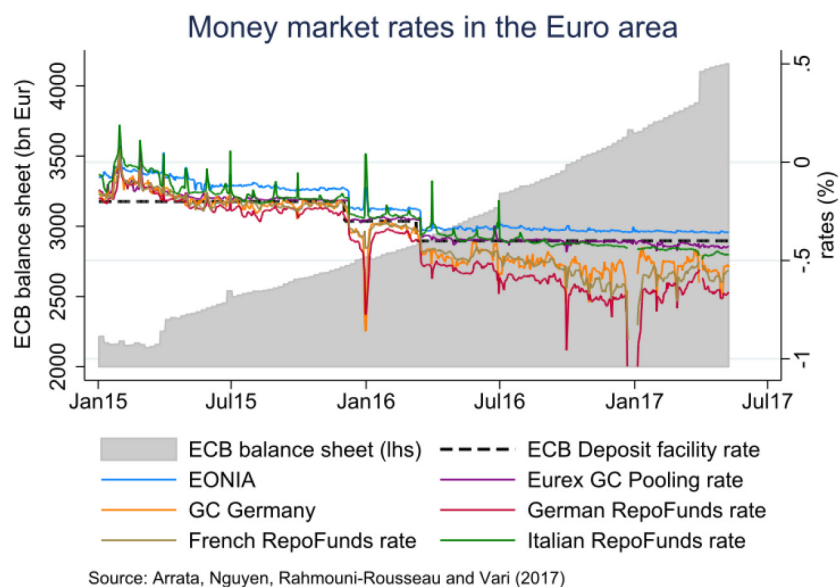
# Achats d'actifs par l'Eurosystème et taux du marché monétaires

## RÉSUMÉ

La baisse de certains taux du marché monétaire en dessous du taux de la facilité de dépôt depuis 2015 a coïncidé avec le lancement du programme d'achat de titres du secteur public par l'Eurosystème (PSPP). Dans ce papier, nous explorons de façon empirique les interactions entre le PSPP et les taux du marché sécurisé (taux repo). Nous documentons les différents canaux par lesquels les achats de titres auraient pu affecter les différents segments du marché repo de la zone euro. A l'aide des données propriétaires d'achats de titres du PSPP et des transactions réalisées sur le marché repo dit spécifique (dans lequel le collatéral est un titre unique et prédéterminé), nous trouvons que le PSPP a effectivement contribué à faire baisser les taux repo, en particulier avant janvier 2017. En moyenne, l'achat d'1% de l'encours d'une obligation par le PSPP est associé à une baisse du taux repo de -0.78 points de base.

Mots-clés : marché du repo, marché monétaire, achats d'actifs

# 1 Introduction

Money market rates trade at historically low levels in most economies, and in some countries below zero. In the Euro area, this is the case for short term unsecured interbank rates, some short term debt instruments such as Treasuries bills or certificates of deposits and also rates on repurchase agreements, also called "repo rates". Repo market rates[1] particularly gained attention[2] as they not only dropped below zero but also below the ECB deposit facility rate (DFR) currently set at -40 bps. At this rate, the ECB is paying interest rate on excess reserves, in principle deterring any market participant (with access to this facility) to lend liquidity below this rate.

Figure 1: Selected money market rates in the Euro area
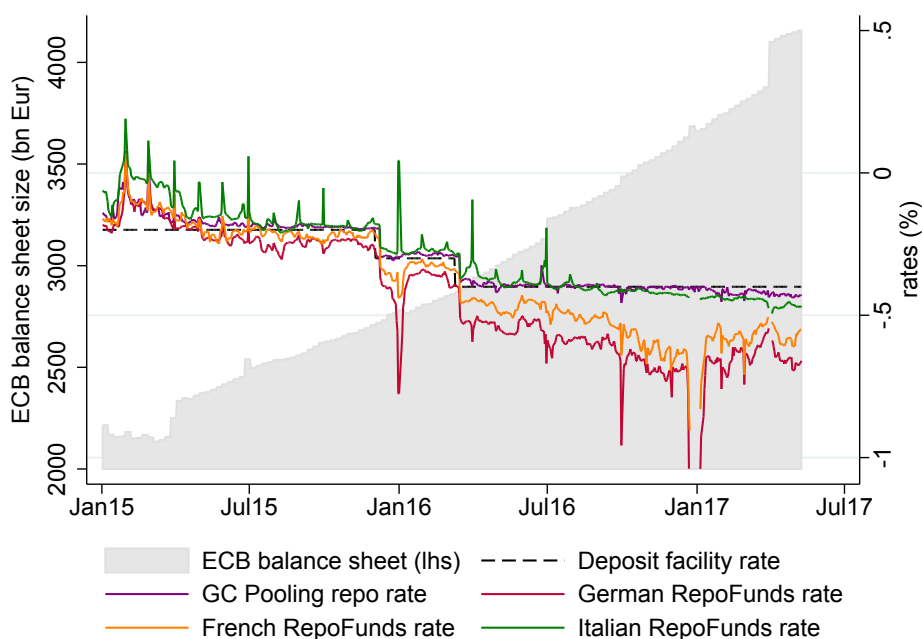


Note: data from Bloomberg, RepoFundsrate. Repo fund rates not shown between the 23th Dec 2016 and 4 Jan 2017 ; and not on 31st March 2017. Repofunds rates are computed from volume-weighted transactions on Brokertec and MTS platforms, and by large composed of special repo rates. We interpret them as such, as opposed to a General Collateral rates, which GC Pooling is an example of. See http://www.eurexrepo.com/repo-en/products/gcpooling

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[1]In repo market, transactions are secured by collateral, ie. borrowers pledge assets such as sovereign bonds against cash.

[2]For instance "Why is the European repo market under pressure?" by FT, Oct. 20th 2016: https://www.ft.com/content/7b413b0c-960f-11e6-a80e-bcd69f323a8b

Two facts are particularly striking in Figure 1: short term interest rates secured by government bonds (repo rates) have continued to decline, despite the steadiness of Eurosystem's policy rates, and have in fact increasingly diverged from the DFR in 2015 and 2016. The deviations of those rates away from the DFR vary according to the issuer country of the collateral and are most extreme for repo transactions collateralized by French and German securities. Those deviations also seem to have coincided with the start of the ECB Public Sector Purchase Programme (PSPP) in March 2015.[3] Explaining the evolution of repo rates and how it could be linked to the bond purchases made under the PSPP will be the main subject of this paper.

The repo market is by far the largest segment of the Euro money market, with a quarterly turnover of 28,000 bn Eur, 10 times the amount traded on the unsecured money market (ECB (2015b)). As such, short term repo rates are critical for the transmission of monetary policy.

We will first consider the impact of the excess liquidity, inherent to any central bank liquidity providing operation on the level of repo rates. Excess liquidity is the liabilities counterpart of asset purchases, but may also be created through refinancing operations. It may be the case that the large amount of central bank reserves created as a byproduct of asset purchases pushed repo rates below the deposit facility rate. This would be directly reminiscent of the US experience, where money market rates have been below the rate of interest on excess reserves (IOER) since 2008 (see Bech and Klee (2011)). This mechanism relies on market segmentation and crucially on the fact that banks with access to the central bank's remuneration of reserves acquire some bargaining power on the money market and remunerate non-banks (which do not receive interest on their reserves) at a lower rate. This seems consistent with recent findings on the Eurosystem PSPP (Koijen et al., 2017) showing the final counterparties of asset purchases were mostly counterparties with no direct access to the DFR in the Euro area. According to this first hypothesis, the larger the amount of central bank liquidity in the system, the larger should be the gap between money market rates and the DFR. This mechanism is described in more details in section 2.1 and some anecdotal evidence are presented in order to support its empirical relevance. The bulk of this paper, and its main contribution focus however on different measures of individual bond scarcity.

We will devote most of the empirical analysis on the effect of Eurosystem purchases on

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[3]The ECB Public Sector Purchase Programme was started in March 2015 as part of the the ECB asset purchases program. The programme focuses on bonds issued by Euro area governments, public entities and supra-national institutions. It is the largest bond buying program in the history of the Eurosystem, and colloquially known as "Quantitative Easing".

specific securities. By purchasing bonds, the Eurosystem mechanically decreases the net supply available in the market and makes these bonds all things equal more precious. Some financial intermediaries may need these bonds for different purposes (for instance to deliver them after a short sale or for regulatory reasons) that we detail in section 2.3. As their main motivation to enter in a repo transaction is to borrow this bond against cash, they might be ready to lend their cash at some relatively lower rate. This phenomenon is known as "specialness" and was famously described in the academic literature in Duffie (1996). In the presence of specialness, repo rates may well decline below the deposit facility rate.

Recovering data from the Brokertec platform where market participants can borrow and lend cash against specific bonds, we are able to analyze the effect of the Eurosystem PSPP on these secured money market rates. We focus on bonds issued by the seven largest Euro area countries, at daily frequency between 2nd January 2015 and 9th May 2017. We investigate at the security level the determinants of repo rates, and whether they have been affected by the purchases made by the Eurosystem. For this purpose, we combine data from Brokertec with proprietary data on purchases of euro area government bonds made under the PSPP program.

Using panel regressions with bond and country-time fixed effects, we find that PSPP purchases have contributed to depressing the level of repo rates. At the opposite, the larger the amount of this bond is available to the market (*i.e.* the larger the amount issued by the sovereign), the higher its repo rate (the lower the cost of borrowing it). This supports the explanation that scarcity of individual bonds affects their repo rates and thus their specialness. We also find that excess liquidity has its own contribution through more aggregated effects.

These findings lead us to consider several policy implications. It may be challenging for the central bank to transmit one-for-one future policy rate movements in a context of increased dispersion of money market rates. Besides, the relationship between repo rates and bonds relative value on the cash market might also reduce the transmission along the yield curve. In order to deal with these issues, central banks have several instruments at their disposal. Some are related to the management of excess liquidity when the floor set by the central bank becomes "leaky", including the perimeter of institutions having access to the central bank's facilities. Setting up and adjusting the parameters of a securities lending facility may address frictions associated with scarcity.

Our paper is related to three strands of literature. First, we contribute to the empirical literature on bond specialness, that includes for instance Jordan and Jordan (1997), Buraschi

and Menini (2002) or Krishnamurthy (2002). More specifically, we study the role of central bank purchases on the specialness premium, like D'Amico et al. (2014), who have conducted a similar exercise in the case of the Federal Reserve's Quantitative Easing and Corradin and Maddaloni (2017), who have explored the impact of Eurosystem's interventions in 2011 on the Italian repo market. The results of these two studies are consistent with ours. Ferrari et al. (2016) also look at the increase in the specialness premium in the euro area but do not use bond-by-bond data for the central bank asset purchases.

Second, in this paper, we make extensive use of the theoretical literature on specialness and in particular of the seminal work of Duffie (1996). Other theoretical contributions include for instance Fisher (2002), Bottazzi et al. (2012) and more recently Huh and Infante (2016) and Duffie and Krishnamurthy (2016). As explained in section 2, our results confirm all the intuitions from this literature.

Third, we also rely on the literature dealing with central bank interventions and money market rates. We will use the results derived in the context of the post-2008 US federal funds markets, to explain part of the decline of money market rates below the deposit facility rate. Contributions to this literature include for instance Bech and Klee (2011), Martin et al. (2013), Garratt et al. (2015) or Armenter and Lester (2017), as detailed in section 2.

The remainder of the paper is organized as follows. Section 2 elaborates on the different mechanisms linking asset purchases and the repo rates. Section 3 describes the data and section 4 outlines our empirical strategy. We then provide our results in section 5 and discuss the policy implications in section 6. Section 7 concludes.

## 2 The repo market and central bank asset purchases: an interplay of different possible mechanisms

The market for repurchase agreements – repo – allows to borrow and lend cash against collateral, ie. a security and generally a bond. For this reason, this market is said to be the market for secured funding, as opposed to the unsecured funding market. A repo transaction involves two counterparties: a counterparty A lends 1 Eur of cash against a bond $i$ (the collateral) in time $t$, at an interest rate $r$ to a counterparty B. At $t+1$ the trade is reversed. A gets $1+r$ Eur of cash and B recovers its bond. A haircut is generally applied to the collateral, that is, one can borrow 95 in cash against 100 of collateral (in this case the haircut is 5%).

Some repo transactions are secured by securities from a basket of collateral. Bonds

belonging to this basket - and by extension repo transactions made against it - are said to be "General collateral" (GC). In those transactions, the collateral that will be delivered is not known when the trade is negotiated, but the bond is listed in the pre-specified GC basket. The main motivation to enter into a GC repo transaction is a priori to lend/borrow cash (Mancini et al. (2016); D'Amico et al. (2014)). This rate is usually seen as a risk-free money market rate in the literature.

Other repo transactions involve a specific security as collateral. When the repo is initiated, it is specified which security (which isin code) has to be delivered against the cash: this market is said to be the special - or specific - collateral repo market (SC). Section 2.3 elaborates on the motives to enter this market and to lend/borrow a specific bond rather than GC. Borrowing a specific bond on the repo market (and thus lend cash), may come at a cost and require to pay a premium for it in the form of a lower remuneration of cash. If for example the GC rate is at -0.40%, a market participant willing to borrow the German Bund maturing on 15 Aug. 2027 and not another bond, might have to accept to lend its cash at -0.50%. This "specialness premium" is the subject of sections 2.2 and 2.3.

In the remainder of this section, we will consider the different possible theoretical mechanisms that could explain how the asset purchases of the Eurosystem caused the decline of repo rates in the Euro area.

## 2.1 The General Collateral repo rate and the role of excess liquidity

Several GC rates coexist in the Euro area. The official benchmark for the short-term secured funding is the Stoxx GC pooling (hereafter GC pooling).[4] It is a basket of currently around 3000 securities, a subset of the securities eligible as collateral for Eurosystem refinancing operations.[5]

As can be seen on Figure 2, the GC Pooling has declined in absolute terms and also with respect to the DFR. Several factors can account for this.

A decline of money market rates in the wake of an increase of liquidity does not sound

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[4]See ECB (2015a). Stoxx is the name of the company publishing the interest rate. GC stands for general collateral. "Pooling" is a method of collateral management, where the cash-borrower can substitute securities at any time in his collateral pool.

[5]Only securities rated at least A- are eligible. This basket includes debt issued by Central governments, regional governments and supranational institutions. Some highly rated Covered bonds are also included. Among the seven countries largest Euro-Area Economy, bonds issued by Spain and Italy are not eligible in the Stoxx GC pooling basket. They are however eligible in the Stoxx GC Pooling Extended basket, which trades a levels close to the simple Stoxx GC Pooling also called Stoxx GC Pooling ECB Basket.

Figure 2: GC Pooling, deposit facility rate and excess liquidity
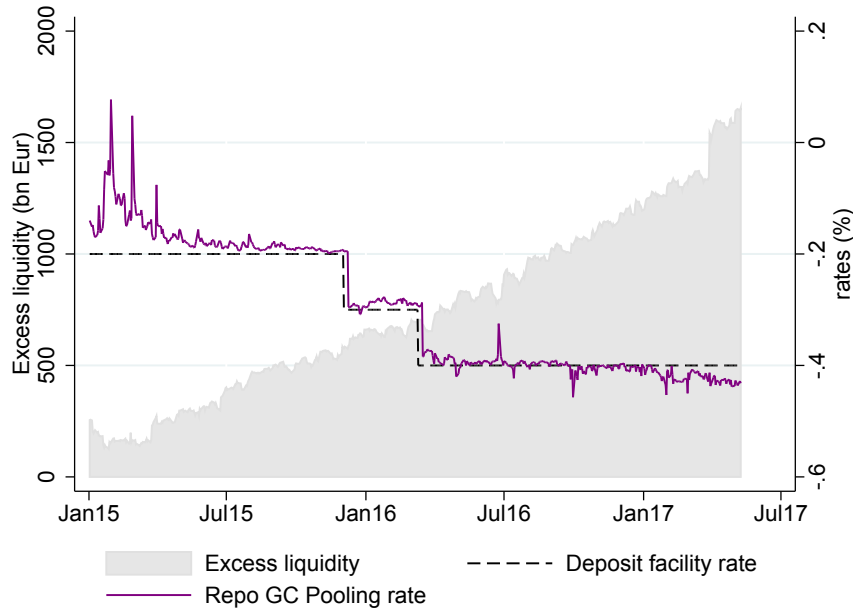


Note: Excess liquidity computed as (current accounts held at the Eurosystem + recourse to the deposit
facility - reserve requirements - recourse to the marginal lending facility), source: ECB SDW and Bloomberg.

particularly mysterious. First, the "liquidity effect" is well documented both empirically and
theoretically. However, theoretical works modeling short term money market rates predict
that liquidity should exert downward pressures on interest rates until they reach the deposit
facility rate of the central bank (see for instance Ennis and Keister (2008) or Vari (2015) for
the Euro area). This is what happened in 2015.

However, GC Pooling rates have declined below the DFR especially from the second half
of 2016 onwards. The DFR should constitute a *de facto* floor for all money market rates in
the Euro area. No agent should be willing to lend their cash below that rate. This situation
is reminiscent of the US money market. Bech and Klee (2011) show that segmentation
between banks (that have access to the deposit facility of the central bank) and non-banks
(that do not have access) in an environment of large excess liquidity drove the effective Fed
Funds rate below the rate of remuneration of excess reserves. Excess liquidity reinforces the
bargaining power of banks that can remunerate the liquidity of non-banks at a rate lower
than what they earn by depositing this liquidity at the central bank, thus earning a profit.
Applying this framework to the euro area repo market, where similar segmentation exists
could explain why the differential between GC repo rates and the DFR persists.

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A look at the participants in the GC Pooling market shows that a certain number of foreign participants do not have access to the Eurosystem deposit facility. Thus, they are unable to arbitrage the difference between placing their cash at the central bank and lending it in the repo market.[6] Moreover, contrary to previous episodes of central bank liquidity expansion by the Eurosystem, the PSPP is likely to have directly increased cash holdings of non-banks.[7] Koijen et al. (2017) study how investors have rebalanced their portfolios during the first quarters of the PSPP by selling securities to the Eurosystem. In particular, foreign (that is, non-euro-area) investors, which are likely to include a sizable proportion of non-banks, seem to have been substantial sellers to the program.

## 2.2 The links between GC rate(s) and SC rates

Besides GC pooling which has the largest collateral basket, there also exists several national GC baskets: a GC basket constituted of unspecified German sovereign bonds, another one of French unspecified sovereign bonds, *etc*. We construct the time series (see Figure 3a) of those national GC repo rates from transactions against these baskets made in the repo platform Brokertec. Section 3 describes in more details the database.

We first observe that there is a clear hierarchy between the different repo rates, presumably reflecting credit risk or particular services offered by GC of certain countries.[8] Interestingly, end of quarter and end of year seem to be responsible for heightened volatility, reflecting also sometimes opposite patterns between core and peripheral euro area countries. This strongly suggests swaps of collateral at end of accounting periods, for instance. This aspect is documented in the US for instance by Duffie and Krishnamurthy (2016) and related to the implementation of the Supplementary Leverage Ratio (SLR).

Second, we observe that GC repo rates have been diverging since 2016, as shown on Figure 3b. Interestingly, GC rates in Italy and Spain seem to remain effectively bounded by the deposit facility rate. In Germany and France, GC repo rates trade at significantly lower

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[6]This list is public and can be found on the website of EUREX: http://www.eurexrepo.com. Cross-checking this list with the ECB MFI statistics show that several participants do not have access to the Eurosystem deposit facility.

[7]By contrast, the two 3-year LTROs launched in late 2011 and early 2012 injected liquidity primarily in the banking sector since only banks are eligible to borrow from the Eurosystem, the liquidity might have channeled the financial system differently.

[8]This could seem surprising given that these transactions are cleared by central counterparties (CCP) (as explained at the beginning of this section). CCP already apply haircuts that should take into account the difference of credit risk of each underlying collateral. Boissel et al. (2014) suggest that divergence between GC rates of European countries could be explained by the pricing of the tail risk that in some states of the world CCPs might default, letting repo market participants with a direct exposure to collateral credit risk.

## Figure 3: GC repo rates divergence by jurisdiction

Panel (a) shows GC rates by countries, computed as daily volume-weighted average of rates on trades made against GC baskets in Brokertec. For sake of readability, we drop data between the last week of December 2016 and first week of January 2017. Panel (b) shows a scatterplot of the spread of each country GC rate against the deposit facility rate and the level of excess liquidity.

### (a) GC repo rates for selected countries
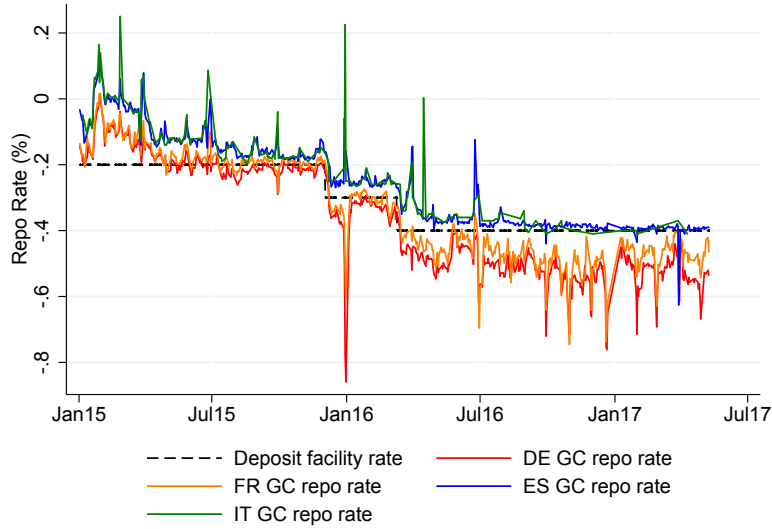


### (b) Spread of each GC repo rate against the deposit facility rate and excess liquidity. Data shown up to 1500 bn Eur of excess liquidity.
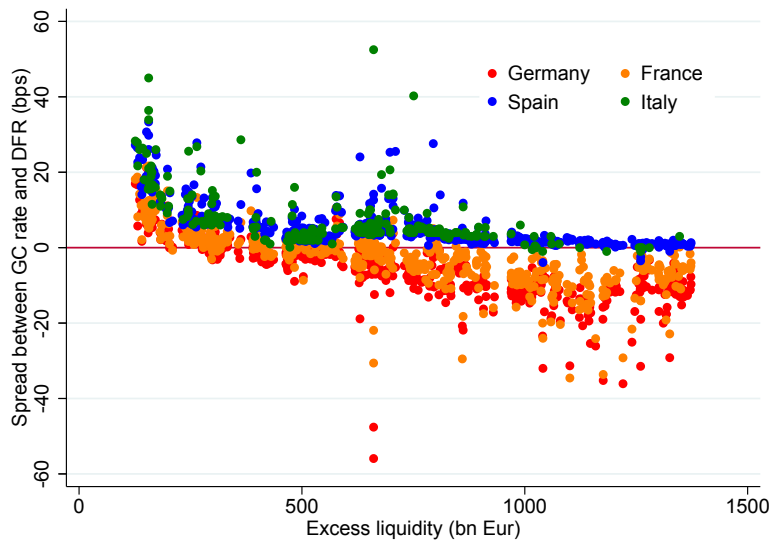
levels, suggesting that excess liquidity affects differently the different euro area jurisdictions. A simple elasticity analysis suggest that beyond 500 bn Eur of excess liquidity, Italian and Spanish GC remain muted and floored by the DFR, while each extra 1 bn Eur of excess liquidity is associated with -1 bps in the German and in the French GC. This makes sense in a world where market participants without access to the DFR have indeed strong preferences to park their liquidity against core countries GC.

On Figure 4 we plot country GC rate *vs.* SC rates for the bonds of the same countries. It shows a large dispersion of SC rates, with some bonds trading sometimes 100 basis points below the country-GC rate. In each country, GC rates behave as the upper envelope of SC rate. This makes sense as the holder of a bond that could be both lent in a GC basket or in the SC market has *a priori* no reason to fund in the GC market if it can fund with the same security at a cheaper rate in the SC market (that is, the bond has a specialness premium). Conversely, if the SC rate was higher than the GC rate, there would be an arbitrage opportunity. In that case, one could make profit from borrowing the security at the SC rate and lending it at the GC rate.

These observations lead us to consider the following possibility: it could be the case that bonds on the Euro area repo market are so scarce, that they all have values on the repo market. As a result, GC rates do not reflect risk-free funding rates (as it is often assumed in the literature). Instead, GC rates are just the highest SC rates and are below where the risk-free rate should be (if we were able to observe it). When all bonds are valuable in the SC repo market, the GC rate is not necessary reflecting a risk free rate and the GC-SC spread (the specialness premium) is not an accurate measure of the value of a bond on the repo market. In our empirical analysis we will therefore use the SC rate instead of the GC-SC spread.

## 2.3   The effect of bond scarcity on SC repo rates

### 2.3.1   The SC repo market and PSPP purchases

Following Duffie (1996), we assume that some specific securities are actively looked after in the repo market. This happens for instance when a financial intermediary "short sells" a security. That is, agreeing to sell a security he currently does not possess. In order to deliver the security, the financial intermediary might either try to buy it in the bond market, or borrow the security in the repo market at the SC rate. It might well be the case that central

Figure 4: Euro area top4 countries GC and distribution of SC repo rates
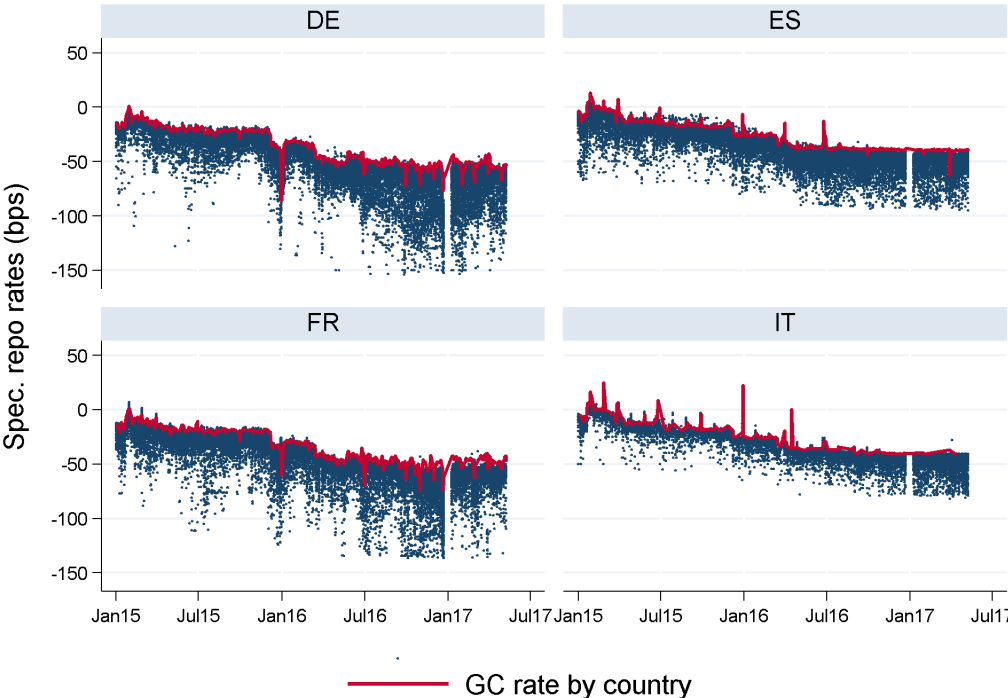


Note: Each dot corresponds to a specific security daily SC repo rate. This SC repo rate is computed as the daily volume-weighted average of SC transactions on each day on this specific security. GC rate is computed from averaging the rates of repo transactions made against each country GC basket. Same figure for all 7 countries of our sample in annex.

banks QE transactions are made with short sellers in the first place.[9]

Failing to restitute a bond at the term of a repo transaction triggers a complex process in Europe, depending on types of agreements signed by the counterparties and largely based on market practices. [10]

The "specialness premium" is the difference between the GC rate and the SC rate of the security. We illustrate with Fig 5 the SC repo market for a given security. The horizontal axis measures the specialness premium. The vertical axis measures the quantity available for trade in the repo market. Supply and demand of collateral for all possible levels of *Spec.premium* are displayed, holding constant the positions of agents in the bond market.

Figure 5: Supply and demand in the SC repo market
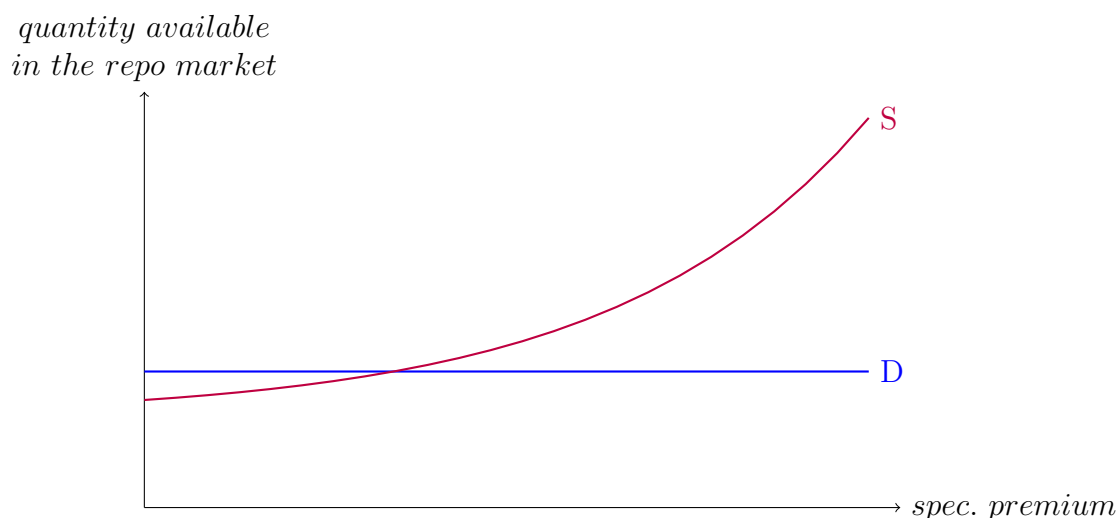


To understand the shape of the supply and demand curves, we review the motives to

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[9]There are other instances where short selling is used, namely in anticipation of a decrease in the price of the security. We do not exclude any case *a priori*.

[10]In worst case, this fail may put a counterparty in default, but most of the time there is a agreement to differ the restitution of collateral. In this case, the repo used to continue interest-free for the counterparty holding cash. However, as noted by ICMA (see https://www.icmagroup.org/Regulatory-Policy-and-Market-Practice/repo-and-collateral-markets/icma-ercc-publications/frequently-asked-questions-on-repo/40-what-happens-to-repo-transactions-when-interest-rates-go-negative/), negative repo rates may create pervasive incentive to fail to deliver the collateral. Thus, market practice in CCPs evolved toward passing the negative cost of bearing cash for the failed counterparty to the failing counterparty. Euroclear for instance remunerates cash balances over 150 million Eur at -70bps since end 2016, see http://www.clearstream.com/clearstream-en/products-and-services/asset-types/cash/a16162/83886 and this cost will be charged to the failing counterparty.

offer and demand collateral in the repo market. As in Duffie (1996), we make the following assumptions on supply and demand: collateral is supplied by the holders of that security, in the form of repos. A key friction in Duffie's model is that some holders might be unwilling to lend these securities at the GC rate, but only at some lower rate, the SC rate, and thus demand a specialness premium to lend their bonds. Some security holders might not want to lend out their holdings, because they are legally barred from it for instance. The link between bond outstanding in the outright market and quantities available for lending in the repo market is not necessarily straightforward (Bottazzi et al., 2012). The total amount outstanding of a given bond is not necessarily made available for loan in the repo market. Conversely, quantity lent in the repo market may also result from reuse. "Reuse" is the activity performed on the repo market whereby agents having borrowed a security will lend again the collateral. This is explored for instance by Singh (2011) with the idea of "velocity of collateral" ie., the number of times a given unit of collateral is lent, which affects the total supply of collateral.

The demand for collateral, in the form of reverse repos, emanates from short sellers. Thus, for a given size of short position in the security market, the demand from shorts is inelastic to the SC rate of the security: the demand curve is constant with the specialness premium.[11]

### 2.3.2    Supply and demand shocks increasing specialness

The specialness premium can increase either from a reduction in the supply or from a rise in the demand of collateral. We illustrate with Figure 6 the impact of negative supply shocks and positive demand shocks.

On the supply-side, several forces could have contributed to decrease the supply of collateral in the Euro area. First, the quantity of securities available for lending in the repo market might have decreased. For instance, it seems that many regulatory constraints force financial intermediaries to hold certain bonds and might prevent them from lending these bonds out on the repo market. Those constraints began to enter into force since 2015 onward, and a non-exhaustive list can be found in appendix.

A major shock on bond markets is also the Eurosystem asset purchase programme. The

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[11]The short seller would not find it less costly to purchase the security on the outright market. Indeed, the increase in specialness translates into an increase in the price of the security. As holders of the bond trading on special can potentially borrow money below other market rates, the security incorporates an additional value, referred to as "repo dividend" by Fisher (2002). This repo dividend implies that everything else constant, a bond trading on special on the repo market will have a higher price on the bond market.

Figure 6: Impact of supply and demand shocks in the SC repo market
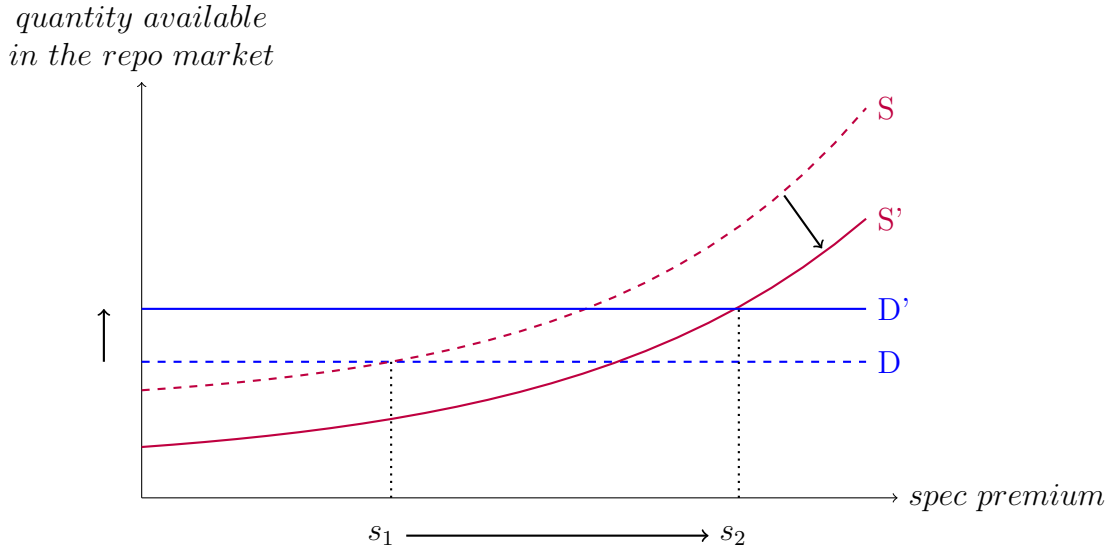


Eurosystem announced on 22th January 2015 the expanded APP (Asset Purchase Program)[12], to provide additional monetary policy stimulus to *"help to bring inflation back to levels in line with the ECB's objective"* and support credit conditions, *"a precondition for inflation to return to and stabilise at levels close to 2%"*[13].The extended package included for the first time purchases of sovereign bonds from all jurisdictions[14] under the PSPP (*Public Sector Purchase Program*). Purchases started in March 2015 at a pace of around 50 bn Eur a month for Euro area government bonds. As of May 2017, the Eurosystem holds 1500 bn EUR of government bonds, among which around 900 bn EUR are rated at least single A. The total Euro area sovereign bond market represents around 7,500 billion EUR, according to the ECB.[15]All in all, the Eurosystem's PSPP could contribute to lowering repo rates because the bonds that are bought are not lent out on the repo market at the GC rate.[16]

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[12]Expanded APP merged the two existing asset purchase programs - CBPP3 on European covered bonds market and ABSPP on ABS market - with a new program on European sovereign bonds (PSPP). Details can be found on the ECB website here: https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html

[13]See https://www.ecb.europa.eu/explainers/tell-me-more/html/asset-purchase.en.html

[14]As of May 2017, the Eurosystem have not purchase any Greek bonds, though, as the country is still under EU-IMF plan.

[15]https://www.ecb.europa.eu/stats/ecb_statistics/escb/html/table.en.html?id=JDF_SEC_OAT_DEBT_SECURITIES&period=2017-05

[16]A Security Lending Facility has been set up (see more details in Section 6), but only for limited quantities and at the bonds' SC rates.

On the demand-side, the most important factor might be related to short-selling. Thus, any factor that increases short-selling should increase a security's specialness. The Eurosystem's PSPP might have triggered a rise in short selling. Indeed, by purchasing bonds on the open market, central banks might directly lead their counterparties to short sell the bonds.[17]

# 3  Data

## 3.1  Repo transactions data

We recover repo transactions data from the trading platform Brokertec, the most used automatic trading system (ATS) for European sovereign bonds (Dunne et al., 2013), between 2nd Jan 2015 and 9th May 2017[18].

The raw data report a bit more than 5 millions of trades collateralized with 1282 different ISINs, representing either a basket (in the case of GC transactions) or specific securities used as collateral. The vast majority of transactions made in Brokertec concerns the SC repo market (87% on average during the period) and this share increased since January 2015 (See Fig7).

Almost all transactions in Brokertec are cleared through a central counterparty (LCH) in charge of applying a public haircut schedule to the collateral depending on the issuer country and the residual maturity. We will not focus on these haircuts in the paper as they were relatively stable during our period under review. In any case, as they are defined for each issuer country for given maturities, they will be captured by maturity-bucket, issuer country and time fixed effects in our regressions. A CCP in principle bears the counterparty risk (Mancini et al., 2016) in the repo transactions, and thus rates should not reflect it. However, Boissel et al. (2014) suggest that divergence between GC rates of European countries

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[17]A large part of the literature on short-selling focuses on the so-called on "on-the-run" bonds, which are special. These bonds are special because they are heavily short-sold by primary dealers to their clients (see for instance Duffie (1996), Fisher (2002), Krishnamurthy (2002), D'Amico et al. (2014) among others). Other bonds which are subject to heavy short-selling activity are bonds included in the basket of future contracts and that are the "cheapest to deliver" (Buraschi and Menini (2002).

[18]See also ICMA: http://www.icmagroup.org/Regulatory-Policy-and-Market-Practice/repo-and-collateral-markets/frequently-asked-questions-on-repo/41-mapping-the-interdealer-european-repo-market/ The secured market represents by far the largest market segment of euro area money markets, with 41% of total turnover in 2015, while the unsecured market segment accounts for only 4% of the market (ECB Euro Money Market Survey, 2015). The infrastructures on which the euro secured market operates are detailed in Mancini et al. (2016). It can be broken down among bilateral, triparty and CCP-based operations. As of 2013, trading via CCPs stands for 71% of total market, up from 42% in 2009. Also, the vast majority of repos with government bonds and other relatively safe securities transit via CCPs.

Figure 7: Daily volumes traded against SC and GC collateral
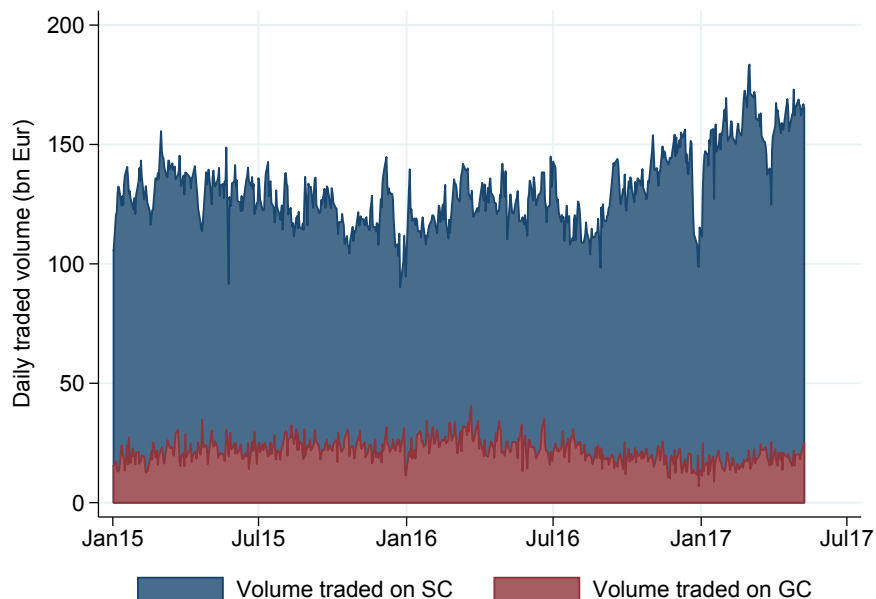


Source: Brokertec, Euro area collateral. Data not stacked.

could be explained by the pricing of the tail risk that in some states of the world CCPs might default, letting repo market participants with a direct exposure to collateral credit risk.

On average, around 170 bn EUR were exchanged each day on the period. For each transaction, we have the trade date, the term, the trade volume, the rate, and the collateral identified by a unique ISIN. We focus on the SC repo transactions of the seven largest Euro-area economies[19] and exclude bonds issued by supranationals and keep only securities issued by central governments.[20] As the majority of transactions (67%) has a maturity of one day and is settled two days after the trade (Spot Next), we also focus on this tenor.[21]

As the highest frequency of our other data is daily, we compute for each security a daily repo rate $Repo\ Rate_{i,t}$, which is the average rate of repo transactions $Repo\ Rate_{i,\theta}$ on this security at date $t$, weighted by volumes exchanged.

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[19]DE, FR, IT, ES, NL, AT, BE

[20]Securities issued by the German agency KFW or the French agency CADES are used on the platform, we exclude them.

[21]80% of transactions having a term of 1 day, according to the latest ECB money market survey (ECB (2015b)). Market conventions imply that a large part of transactions (between 43% and 50%) are settled "Spot-Next", meaning that the cash and the collateral will be delivered two business days after the repo trade has been agreed and terminated one day later.

$$Repo\ Rate_{i,t} = \left[\frac{\sum_{\theta=1}^{n} Repo\ Rate_{i,\theta} \times Volumes_{i,\theta}}{\sum_{\theta=1}^{n} \times Volumes_{i,\theta}}\right]_t \tag{1}$$

Figure 9 shows the distribution of the SC repo rates at the bond-level by country, between 2nd January 2015 and 9th May 2017.

Contrary to the literature (*e.g.* D'Amico et al. (2014) or Corradin and Maddaloni (2017)) we will not use the specialness premium, computed as the spread of SC repo rates against a GC rate. While most studies use this spread to measure the extent of the "specialness" we do not find it suitable in our case. Contrary to previous works that usually focus on a single debt market (*e.g.* the US, the Italian market, *etc.*), we are comparing seven different countries, which might have very different levels of GC rates. For instance, some platforms allow to trade a repo against a GC German bond. It is a repo secured by an unspecified German government bond. This GC rate might not be the same as a general collateral rate against an Italian collateral. It is likely that the rate varies depending *inter alia* on the credit risk associated with sovereign debt. A market participant willing to lend out its cash would probably not lend at the same rate knowing that he could get any German collateral or a bond issued by another country. In most of our specifications, we will control for the general level of interest rates through our time fixed effects and more specifically the levels in each countries, through the country-time fixed effect. Thus, having SC rates or spread between a GC and SC rates at the left hand side would not yield different results, as GC would be captured by the country-time fixed effects.

## 3.2 Eurosystem's purchases and bonds characteristics

For the Eurosystem purchase programme, we use proprietary data of all PSPP transactions made by the Eurosystem, at the security-day level. For each PSPP transaction, we have the trade and settlement dates, the book value, the nominal amount, and the ISIN identifier. The same security might be purchased several times during a day. When this is the case we use the end-of-day holdings of the Eurosystem (*i.e.* we sum the purchases made during the day). Then, we compute the cumulative sum of PSPP transactions at each date, and the ratio of this cumulative purchases on the nominal outstanding of the bond (ie. the share iof this bond held by the Eurosystem under its PSPP programme).

We make use of the Securities Holdings Database (SHS) to compute for each bond the structure of its detention among institutional investors, to explore whether the holding struc-

ture matters or correlates with specific patterns of collateral demand and specialness. A detailed description of the database is given by Fache Rousová and Rodríguez Caloca (2015). We are particularly interested in the detention by inelastic investors, unlikely to lend their bond holdings in the repo market. In the spirit of Koijen et al. (2017), we call inelastic investors: insurance companies and pension funds, households, non-financial corporations and governments. Elastic investors include banks, mutual funds and the foreign sector. Like in the case of PSPP, we compute the share of the nominal outstanding held by these two investors' groups.

For each security, we complement the daily repo and daily PSPP purchases data by bond characteristics, recovered either through the EADB database (Eurosystem's eligible assets database) or Bloomberg (nominal outstanding, issue and maturity dates, issuer rating, coupon rate...). We also recover from Bloomberg and the ECB macro variables such as daily excess liquidity, OIS rates, European stocks volatility index VSTOXX and the CDS spreads for France, Spain and Italy, which were the ones in the sample with a liquid and traded CDS (other countries having negligible default risk).

### 3.3 Panel description

For each country, we remove the first and the last percentile of specialness rates to deal with outliers, and we drop the last week of December 2016 and the first week of January 2017 [23/12/2016 to 07/01/2017] because of heightened volatility at year-end. As we will show, the results are virtually unchanged when we include the outliers and observations from 23/12/2016 to 07/01/2017. The cleaned sample consists of 203,203 observations, for 823 individual securities. Table 1 gives the main descriptive statistics of variable we use in our empirical exercises.

Table 1: Cleaned sample 2nd Jan 2015 - 9th May 2017

| Variable | mean | min | max | sd | obs |
|---|---|---|---|---|---|
| Repo rate (bps) | -40.48 | -153.79 | 10.00 | 20.42 | 203203 |
| Share held PSPP | 0.06 | 0.00 | 0.33 | 0.08 | 203203 |
| Time-to-maturity (yr) | 6.99 | 0.01 | 70.05 | 8.59 | 203203 |
| Nom. outstanding (bn Eur) | 14.52 | 0.00 | 43.19 | 8.26 | 203203 |
| Share held by inelastic investors | 0.21 | 0.00 | 0.90 | 0.17 | 199885 |
| ISIN-Daily volume in Repo (mn Eur) | 294 | 1.00 | 7571 | 453 | 203203 |
| Credit rating (1=AAA) | 2.96 | 1.00 | 8.00 | 2.64 | 203203 |

# 4 Empirical strategy

## 4.1 Baseline specifications

Our aim in this paper is to understand the behavior of special repo rates in the Euro-Area. The left hand-side variable is therefore the SC repo rate for a bond (an isin code) on a given day, constructed from Brokertec, as explained in the previous section. Our main independent variable is purchases of bonds by the Eurosystem under the PSPP. We construct a variable "PSPP", which is equal for each bond to the ratio of PSPP purchases (taken from a Eurosystem dataset) to the total amount outstanding (taken from the ECB eligible asset database), both expressed in nominal values. If the Eurosystem has bought 20% of a given bond under the PSPP, "PSPP" is equal to 0.2 for this bond. In line with the literature, we run our regressions in first differences to deal with the persistence of these variables.

We include bond fixed effects, which capture *inter alia* the original maturity of the bond, its coupon rate, whether it is inflation linked, *etc.* We also include country-maturity bucket-time fixed effects, which capture macro variables (eg. the amount of excess liquidity), the information about the issuer (eg. credit rating), and possibly effects related to maturity buckets in this country (crucially haircuts as we said before) To account for the possibility that error terms might be correlated across similar bonds in terms of maturity or country of issuance, we build 5 maturity buckets and cluster our standard errors at the maturity bucket/issuer country level, resulting in 35 clusters in our regressions.

Our baseline regressions write as follows:

$$\Delta Repo\ rate_{i,t} = \beta \Delta PSPP_{i,t} + FE_i + FE_{country,bucket,t} + \epsilon_{i,t} \tag{2}$$

As in D'Amico et al. (2014), we allow for different types of bonds to be impacted differently by PSPP purchases. It is well known for instance that "on-the-run" bonds (the last issued bond of a given maturity in a given country) is in high demand from a certain number of investors and heavily sold short (see for instance Duffie (1996), Fisher (2002), D'Amico et al. (2014)). As a result, the level of repo rates for on-the-run governments bond might be lower in level (this effect cannot appear in first differentiated regressions) and the sensitivity of repo rates for on-the-run treasuries to PSPP purchases might be larger. We therefore construct a dummy variable equal to one whenever a security is on the run in a given country and equal to 0 otherwise. Symmetrically, we construct a variable "off-the-run" equal to one minus "on-the-run". Then, we interact these dummy variables with the "PSPP

purchases". This regression looks as follows:

$$\Delta Repo\ rate_{i,t} = \beta_1 \text{on-the-run} * \Delta PSPP_{i,t} + \beta_2 \text{off-the-run} * \Delta PSPP_{i,t}$$
$$+ FE_i + FE_{country,bucket,t} + \epsilon_{i,t} \quad (3)$$

Similarly, we construct a dummy variable equal to one when the bond is the "cheapest-to-deliver" (ctd) and 0 otherwise.[22] We also interact these dummy variables with the first difference of "PSPP", the percentage of a given bond issue bought by the Eurosystem. We will run other regressions with interactions. We will notably look at the proportion of bonds held by "inelastic investors". These are investors we suspect to be relatively inelastic to changes the repo market. At last, we will interact our measure of asset purchases with country dummies (to explore the potential heterogeneous effects of the PSPP for each country).

Another set of regressions intends to identify the effect of time varying characteristics common to all bonds. We therefore remove the time or country-time fixed effects and replace them with macro variables, such as excess liquidity, EONIA swaps, the VSTOXX, CDS spreads, *etc.* We will then run regressions of the following form:

$$\Delta Repo\ rate_{i,t} = \beta_1 \Delta PSPP_{i,t} + \beta_2 Excess\ liquidity_t + \beta_3 OIS_t$$
$$+ \beta_4 VSTOXX_t + \beta_5 CDSs_t + \beta_6 SLF\ vs\ cash + \beta_7 End_{m,q} + FE_i + \epsilon_{i,t} \quad (4)$$

The $SLF\ vs\ cash$ dummy captures the period of implementation of the Securities lending facility against cash. From Dec 15th 2016, under this facility, the Eurosystem lent part of the securities purchased as part of the PSPP against cash (limited to a total usage by counterparties at 50 bn Eur).[23] $End_{m,q}$ is a dummy taking one at accounting reporting dates, namely end of month and end of quarter that are responsible of spikes in the repo rates times series. While this is not the core subject of this paper, Annex A provides some details on how regulations may be related to these calendar dates volatility.

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[22]An agent having sold a future contract on the "5-year German bond" has the possibility to deliver several bonds, at the contract maturity date. The "cheapest-to-deliver" is, among the bonds allowed for delivery, the bond which offers the highest return for someone having sold the future contract. It is therefore in high demand on the repo market. Traders borrow it, in order to deliver it see Buraschi and Menini (2002). We expect this type of bonds to have a less elastic supply and thus to be affected more heavily by PSPP purchases.

[23]Details can be found here: https://www.ecb.europa.eu/mopo/implement/omt/lending/html/index.en.html

## 4.2 Possible endogeneity issues

The outstanding amount of a government bond may vary along the life of the security. First, bonds are usually issued in several auctions, or re-issued many years afterwards (taps). Debt buybacks are also used by some of Euro area debt management offices, generally to smooth the redemption profile of their liabilities. As a result, we cannot consider the denominator of "PSPP", our main independent variable as pre-determined. Should we be concerned about possible endogeneity bias and in particular about reverse causality? We think we should not: debt management policy is generally extremely predictable, and pre-announced each year for the fiscal year to come. It is also to be noted that buybacks are not taking place at all in some jurisdictions and when they happen, they seem to depend on fiscal considerations, such as smoothing the repayment profile of the sovereign.[24] As a result, it is reasonable to assume that by large, the outstanding amount of a given bond in not determined by its specialness premium.

PSPP purchases, on the contrary, may be impacted by specialness. The Eurosystem intends to conduct its interventions in the bond market *"in a gradual and broad-based manner, aiming to achieve market neutrality in order to avoid interfering with the market price formation mechanism*[25]*"*. These aspects were further clarified by ECB board member Benoit Coeuré[26]: *"One key principle underlying the implementation of the PSPP is [...] market neutrality of our operations. [...] To this end, we will take particular care to avoid exacerbating any existing market frictions. More specifically, we will try to avoid, to the extent possible, purchasing specific securities such as current cheapest-to-deliver bonds underlying futures contracts, securities commanding special rates in the repo market as a sign of temporary scarcity, and other assets displaying significant liquidity shortages."*

An endogeneity bias arises if PSPP purchases are refrained based on a bond repo rate. An extreme case would be to observe that PSPP purchases are positively correlated with repo rate. This effect goes in the opposite direction from the one we expect (*i.e.* PSPP purchases decrease repo rates). Thus, results obtained without treating the endogeneity bias should be seen as a lower bound (in absolute value) of the effect of PSPP purchases on repo

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[24]The OECD Sovereign Outlook report (2013) highlights that "the dominant motive behind bond buybacks is "to smooth the redemption profile" and "to mitigate refinancing risk". "To increase liquidity" and "to offset large cash income and remove small stocks" are two other reasons mentioned by OECD DMOs".

[25]Official statement: https://www.ecb.europa.eu/mopo/implement/omt/html/pspp.en.html

[26]*"Embarking on public sector asset purchases"* Speech by Benoit Coeuré, Member of the Executive Board of the ECB, at the Second International Conference on Sovereign Bond Markets, Frankfurt, 10 March 2015

rates.[27]

# 5 Results

Overall, our results clearly confirm the effect of the PSPP on repo rates. Table 4 displays our baseline regressions, showing the effect of PSPP purchases (as a share of the outstanding amount) with different set of fixed effects. As expected, coefficients are negative and strongly significant. It implies that the higher the amount purchased by the Eurosystem of a given bond on a given day (scaled by the total amount outstanding), the lower the rate of this bond on the repo market. The magnitude and significance of coefficients is little affected by the inclusion of fixed effects. Looking at the third column of table 4, one can see that buying 1% of the total outstanding (that would represent on average 150 million), would result in a decrease of 0.78 basis points of repo rates. The economic importance of the effect is line with the literature. It is above the estimates found for the US market by D'Amico et al. (2014) and below those of Corradin and Maddaloni (2017) for the Italian repo market.[28]

It is very likely that the effect of bond purchases on repo rates is heterogeneous depending on the characteristics of the bond. Therefore, we allow for these heterogeneous effects to show up by interacting the variable "PSPP" with different dummy variables. The second column of table 5 shows the effect of PSPP purchases on "on-the-run securities" *vs.* "off-the-run securities". As predicted by theory, "on-the-run" securities are more affected by central bank assets purchases than other securities, being also the most liquid and thus the most short-sold (Duffie, 1996). The effect is around twice as large, in line with the estimates of D'Amico et al. (2014) for the US market for on-the-run vs. off-the run securities. It is due to the fact that on-the-run securities are already heavily short-sold by market participants. Similarly, looking at the third column of 5, one can see that the so called "cheapest-to-deliver" securities (that are usually more heavily short-sold than other other securities) are once again more affected by the PSPP than other securities.[29] In the fourth column, we explore the effect of the PSPP depending on the type of investor holding the bond. In

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[27]Similarly, in the event where the total amount outstanding depended on specialness, it would imply that the observed effect of the "PSPP" ratio is weaker than the actual effect.

[28]These differences could be related to the securities lending program of the central banks when they conduct the purchases, as discussed in section 6.

[29]Strictly speaking, one should add the dummy variables "on-the-run" and "cheapest-to-deliver" separately from their interaction terms. In practice, the dummies are not significant and do not change the results. Skipping them allow to lighten the table. Results including them are available upon request. This problem does not arise in the last two columns of table 5, because the variable original maturity and the country dummy variables without interactions are already contained in the bond fixed effects.

line with theory we find that bonds held by investors relatively inelastic to repo market conditions (such as pension funds, households, non-financial corporations and governments) are more sensitive to asset purchases. Purchasing 1% of the outstanding amount leads to a decline of 1.8 basis point for a bond which is wholly held by inelastic investors. This is due to the fact that those investors will not arbitrage the specialness premium when it starts to rise. At the other extreme, purchasing 1% of the outstanding amount of a bond held completely by "elastic investors" leads to a decline of only 0.48 basis points. A possible interpretation of this result is related to differentiated effects of PSPP purchases when the purchased bond is held in inventories by the direct counterparties of the central bank (ie. banks), as opposed to the case when the counterparties do not hold the bond. Let's assume the purchased bond is held by inelastic investors (ie. insurance companies, for instance). In this case, the purchased bond may be delivered to the central bank by its regular bank counterparty through a short-sale, then covered in the SC repo market.

We conclude our analysis of heterogeneous effects, with country dummies. As one can see from the last column of table 5, the magnitude of the effect differs markedly between the different countries. The most affected countries are in order: Spain, Italy and Germany.[30] In Spain and Italy, purchasing 1% of the outstanding would result in a decrease in repo rates greater than 1 basis point. Theoretically, this difference could be explained for instance by the fact that these three countries have securities lending program that are more penalizing than others (as discussed in section 6). One should keep in mind that the total amount of purchases depends on the country capital key in the ECB capital, and that the size of debt market varies widely across countries.

In order to isolate time-varying factors that can affect repo rates, we remove time fixed-effects. Results are shown in table 6. The first column recalls our benchmark regression with bond and country-time fixed effects. The following three columns run regressions with time varying variables, with different set of fixed effects (but no time fixed effects). The results indicate that excess liquidity has a negative effect on repo rates. For 1 additional billion of excess liquidity, the SC repo rate for any given bond declines by 0.022 bps. It implies that for 1,000 bn of excess liquidity created through asset purchases, the average effect on SC rates would account for -22 basis points. This could be due to the fact that PSPP places some

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[30]Interestingly, our estimates point to a smaller effect in absolute value for Italy than Corradin and Maddaloni (2017) who find that purchasing 1% of the outstanding leads to a decline of 5 basis point. This could be due to the fact that no securities lending program was available during their sample period. They also look at period of heightened market stress, were central bank purchases could have additional signaling effect, compared to our sample period.

cash in the hands of agents which are not banks, without access to the DFR. Those agents, by construction, then need to deposit this cash with a bank which has an account with the Eurosystem. As explained in Section 2, this redistribution of cash toward non-banks could lead to some competition issues that could depress money market rates. The purchases of some bonds may also affect the price of other non-purchased bonds, which we may capture with this variable.

Interestingly, excess liquidity created through MRO and LTRO refinancing operations seems to depress repo rates too. This can be due to the fact that when LTROs and MROs increase, so does the amount of collateral that banks pledge to the Eurosystem. It thus withdraws collateral (including government bonds) from the stock of collateral available for lending and thus lowers supply on the SC repo market.[31]

Both end of month and end of quarter dummies' coefficients are negative and highly significant. This might reflect window dressing by financial institutions, in particular from banks, around accounting and regulatory reporting dates. First, financial institutions might be willing to hold HQLA on their balance sheet to improve their regulatory ratios such as the LCR, etc. In order to hold these bonds, they avoid lending them during reporting dates, hence reducing the supply of bonds on the SC repo market. In Duffie's model specialness arises precisely because some agents are unwilling to lend their bonds. Figure 7 suggests that these dynamics might have been at play at least at year-ends, noticeable in the daily volumes exchanged on the SC market. Second, banks have incentives to deleverage before having to report the size of their end-of-period balance sheet. Lending securities on the SC market or intermediating such lending, increases leverage (banks have to borrow cash in any case when they engage in such an activity).

Annex A gives some details about each kind of regulatory constraints. In particular, calendar-dates effects can be related to window dressing around LCR and leverage ratio reporting dates.

We control for possible seasonnality patterns with month and day variables, the first being the number of the month (1-12) and the second the number of the day (1-31), and also for the last day of the ECB maintenance period.

The "SLF vs cash" dummy corresponding to the period of implementation of the facility against cash collateral (from 15th dec 2016) is associated with alleviated pressure on the repo market, consistent with theory. Yet it should be stressed that this period might also see other changes that we have not identified. Thus, the interpretation of the coefficient

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[31]Banks have to provide collateral as a guarantee to borrow from the Eurosystem.

should be particularly prudent.

We also run several robustness checks which are shown in table 7. In the first column we exclude the first semester of 2015, on the account that the program only starts in March and that money market rates are rather volatile during this period. Then, in the second column we exclude the whole year 2015. In the third column, we include the outliers and the period of late 2016 early 2017. At last, in the fourth column we remove inflation linkers. Our results little affected by these changes and thus consider our results robust to these changes.

# 6 Implications for monetary policy and the exit strategy

Our results suggest that the PSPP has depressed repo rates both by intensifying the scarcity of the bonds and by increasing the amount of excess liquidity. Both may raise a number of monetary policy issues.

## 6.1 Should low repo rates *per se* be a concern at all?

The extent to which low repo rates increase the dispersion of money market rates might affect monetary policy pass-through via different channels. Low repo rates and the persistence of significant specialness premia might prove challenging for the corridor system and in particular the effectiveness of the deposit facility rate to control the dispersion of money market rates. In a sense, their deviation may signal a potential trade-off between short rates controllability by the central bank and the expansion of its balance sheet through asset purchases.

First, GC rates are seen as reflecting the price of liquidity and their deviation from monetary policy-controlled rates might at least pose communication problems. We showed that in reality GC rates might still embed general preferences about country-specific collateral and different response to excess liquidity. GC rates also behave like the upper envelope of all SC rates (see section 2.2), as in a GC transaction rational agent would always deliver the collateral that has the lowest value in the SC market. This suggests that GC rates are not completely pure risk free rate independent from the other segment of the repo market which prices bond scarcity. Thus, it is unsure that a rise of the deposit facility rate by the central bank would be transmitted one for one to other money market rates in the first place, as long as large excess liquidity persists. The deterioration of the monetary policy pass-through

to money market rates may also be related to other structural determinants, such as some regulations. Such questions have been raised in the case of the US for instance (see for instance Frost et al. (2015) Duffie and Krishnamurthy (2016) or Berentsen et al. (2015)).

Second, even if SC rates are *a priori* collateral-driven and less under the influence of monetary policy, they should reflect in the bond yields themselves. Empirical works by Jordan and Jordan (1997) and D'Amico et al. (2014) confirm this relationship in the case of US treasury market. Thus, the existence of a feedback loop between repo rates and bond yields might also affect the transmission of monetary policy rate to the yield curve. As a security trades at lower and lower rates on the SC repo market, its price on the outright bond market tends to increase, through the existence of a "repo dividend"(see for instance Duffie (1996), Fisher (2002)). Intuitively, the existence of a specialness premium attached to a bond is generating an income from lending it in the repo market, which should be discounted in its price. Thus, by making bonds more special, asset purchases also contribute to increasing bond prices and lower their yields.

Third, specialness reflects the presence of market frictions, namely a demand for specific bonds (a form of imperfect substituability) and imperfect arbitrage. To the extent that the PSPP reinforces bond scarcity, it means that it imposes a greater cost on those who need to borrow them, or those who hold them without being allowed to lend them out. For instance, if banks borrow the bonds to fulfill their regulatory obligations (or are not allowed to lend them out), they forgo the difference between the repo rate and the deposit facility rate. The distributional effects of these costs and their impact on welfare remains unclear but would be an interesting venue for further research.

## 6.2 What can the central banks do about the low level of repo rates?

The two previous subsections have identified two possible problems associated with the current level of repo rates. Central banks have instruments, if needed, to offset each of them.

In principle, GC rates – as understood as purely liquidity-driven rates – should not trade below the DFR in a world where either: (i) liquidity in hands of non-banks is low (ii) non-banks have access to the central bank (iii) perfect competition and arbitrage in the interbank market. Accordingly, central banks could adjust their operational framework for monetary policy to include instruments accessible to non-banks, as was done in the US with overnight reverse repo facility that is opened to mutual funds, for instance (Frost et al.

Figure 8: Impact of the introduction of the SLF on the SC repo market
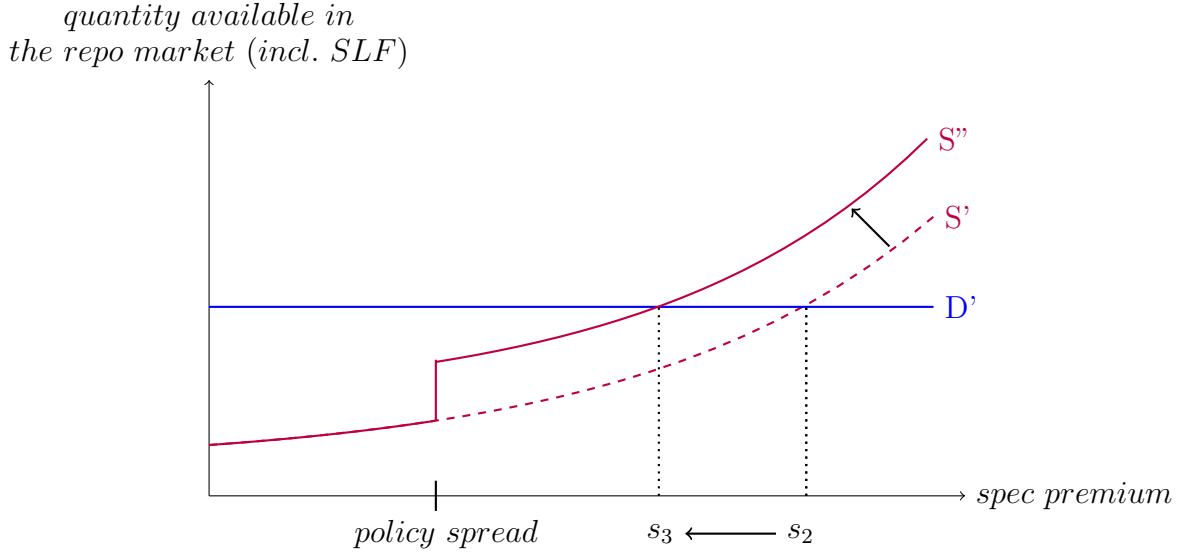


Note: we illustrate the impact of the introduction of a securities lending facility (SLF). Above a given "policy rate" announced by the central bank, which corresponds to a level of specialness premium, bonds are lent at the SLF against GC - or less special - collateral. This shifts upward the supply curve in an hypothetical repo market constituted of the private repo and SLF. As a consequence, after its introduction, the specialness premium at equilibrium decreases from $s_2$ to $s_3$. This result is in line with the theoretical framework built by Duffie and Krishnamurthy (2016) on the US money market. In practice, in the SLF (against securities as collateral) of some euro area central banks (Germany, France, Netherlands for instance), any monetary policy counterparty can borrow the security at the central bank against a GC security, for a quantity not above 200 mln EUR, at a "policy spread" that is at least equal to 10 bps below the GC rate.

(2015)). We raise, though, the possibility that some country-specific GC rates are currently not completely liquidity-driven, in a world where all bonds from a given country trade on special. In that case, GC rates may reflect the lowest SC rates of specific bonds that are relatively less in demand in the SC repo market.

This suggests that besides liquidity management, frictions associated with bond scarcity could be alleviated by the central bank. The theoretical literature supports the idea of lending bonds acquired by the central bank through a securities lending facility. Figure 8 represents the impact of the introduction of the SLF in the SC repo market of a given security, when such a SLF offers bonds for a minimum spread against GC (here, 10 bps).

Our empirical results suggest that the period of implementation of the SLF against cash was already associated with lower pressure on the special repo market, in spite of its limited

Table 2: Securities lending facilities (SLF) against security conditions

| Country | SLF cost, to borrow a specific security | Limits |
|---|---|---|
| Germany | GC rate minus some fixed (confidential) spread | 200 mln EUR/security |
| Netherlands | GC rate minus 10 to 25 basis points | 200 mln EUR/security |
| France | GC rate minus 10 to 25 bps | 200 mln EUR/security |
| Italy | The special repo rate for that security minus an additional penalty of 10 basis points | 200 mln EUR/security |
| Spain | The most penalizing of these two rates: special repo market rate for that security or the GC rate minus 10 basis point | 200 mln EUR/security |
| US | Minimum bid rate of 5 basis points | 90% limit on holdings |

Table 3: Securities lending facilities (SLF) against cash conditions

| Country | SLF cost, to borrow a specific security against cash | Limits |
|---|---|---|
| Eurosystem | -30 basis points below the ECB deposit facility rate | 50bn Eur in total |

Source: central banks' respective websites

size. There are arguments to support the increase in the size of the securities lending, and making its pricing as attractive as possible. In theory specialness remains only because some agents are not willing to lend out the securities they hold. So far, Euro area national central banks manage their securities lending on a decentralized basis (each have different pricing conventions). In the US, specialness has been much less prevalent (Fleming et al., 2010; D'Amico et al., 2014). One reason for this might be related to the attractive pricing of securities lending programs of the New York Fed. The overnight securities lending facility offers specific securities against any general collateral at a fee as low as 5 basis points[32]. In contrast, some central banks of the Eurosystem lend specific securities way below market rate (*i.e.* on more expensive terms), as described on table 2.

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[32]Michael Fleming, Frank Keane, Jake Schurmeier, and Emma Weiss, "A Closer Look at the Federal Reserve's Securities Lending Program," Federal Reserve Bank of New York Liberty Street Economics (blog), August 17, 2016, http://libertystreeteconomics.newyorkfed.org/2016/08/a-closer-look-at-the-federal-reserves-securities-lending-program.html

# 7 Conclusion

In this paper, we have shown the links between the Eurosystem PSPP and the low level of repo rates in the Euro area since 2015. We found the PSPP contributes to depressing repo rates both by increasing the scarcity of the bonds purchased and through more aggregated effects by increasing the amount of excess liquidity. Increased dispersion of repo rates below the central bank remuneration of reserves might be challenging going forward. Not only the control over short term interbank rates may be more difficult, but it also raises the question of the transmission of monetary policy to bond yields and asset prices. Central banks have instruments that could, in case, be used to mitigate such kind of distorsions. Finally, our study shed light on the possibility that central bank purchases are accommodated by short sales and covered in the repo market in the first place, contributing to a better understanding of the mechanisms behind asset purchases programs.

Figure 9: Distribution of SC repo rates by bond and by country

We exclude the last week of December 2016 and the first week of January 2017 to exclude year-end volatility. Each point represents the daily volume-weighted rate traded on the Repo special market and on a unique special bond.
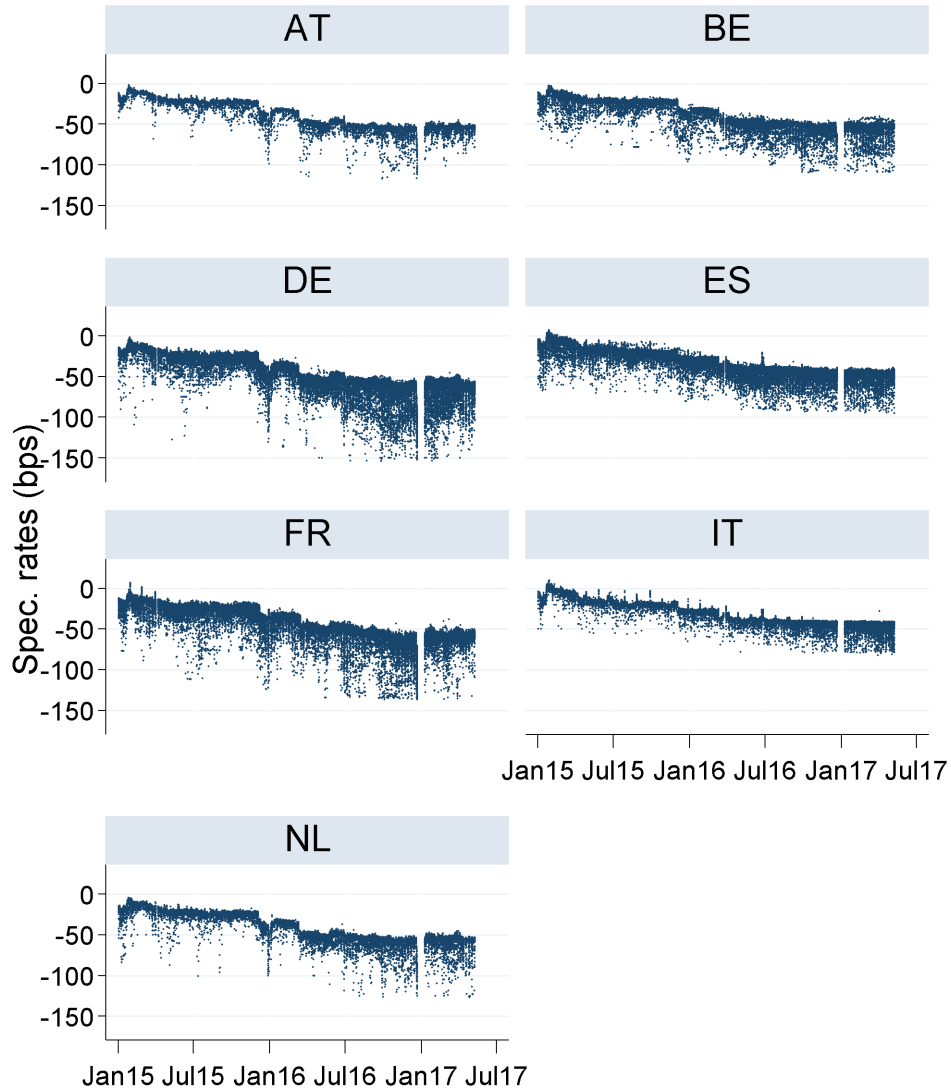
# 8    Tables

Table 4: Effect of PSPP purchases on SC repo rates

This table shows the impact of PSPP purchases on "Spot-Next" SC repo rates. PSPP variable is the variation of the share of the bond outstanding held by the PSPP. We use various set of fixed effects. The number of observations may change due to singletons. Standard errors are clustered at the maturity bucket-country level.

|  | (1) SC repo rate | (2) SC repo rate | (3) SC repo rate |
|---|---|---|---|
| PSPP | -0.583*** | -0.765*** | -0.781*** |
|  | (0.162) | (0.138) | (0.145) |
|  |  |  |  |
| Bond FE | No | No | Yes |
|  |  |  |  |
| Country-Bucket-Time FE | No | Yes | Yes |
| $R^2$ | 0.000 | 0.509 | 0.512 |
| Observations | 202311 | 201864 | 201855 |

Standard errors in parentheses, clustered at the maturity bucket-country level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Effect of PSPP purchases on SC repo rates, differentiated effects

In this table we use various interactions terms to account for possible heterogeneous marginal effects. PSPP variable is the share of the bond outstanding held by the PSPP. Inelastic and elastic refer to the share of each security held by specific types of investors (see p18)

|  | (1) SC repo rate | (2) SC repo rate | (3) SC repo rate | (4) SC repo rate | (5) SC repo rate |
|---|---|---|---|---|---|
| PSPP | -0.781*** (0.145) | | | | |
| PSPP x on-the-run dummy | | -1.163*** (0.279) | | | |
| PSPP x off-the-run | | -0.583*** (0.100) | | | |
| PSPP x cheapest-to-deliver | | | -1.407*** (0.506) | | |
| PSPP x not-ctd | | | -0.776*** (0.147) | | |
| PSPP Inelastic | | | | -1.778+ (1.055) | |
| PSPP Elastic | | | | -0.476** (0.202) | |
| PSPP x DE | | | | | -0.961*** (0.278) |
| PSPP x FR | | | | | -0.400*** (0.110) |
| PSPP x IT | | | | | -1.152** (0.497) |
| PSPP x ES | | | | | -1.233*** (0.102) |
| PSPP x NL | | | | | -0.282*** (0.0867) |
| PSPP x BE | | | | | -0.605*** (0.190) |
| PSPP x AT | | | | | -0.476*** (0.0946) |
| Bond FE | Yes | Yes | Yes | No | Yes |
| Country-Bucket-Time FE | Yes | Yes | Yes | No | Yes |
| $R^2$ | 0.512 | 0.512 | 0.512 | 0.504 | 0.512 |
| Observations | 201855 | 201855 | 201855 | 198711 | 201855 |

Standard errors in parentheses, clustered at the maturity bucket-country level.
+ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$     32

Table 6: Effect of PSPP purchases and excess liquidity on SC repo rates

In this table, we remove fixed effects to capture the impact of time varying variables such as excess liquidity and the impact of end of periods. "SLF cash dummy" corresponds to the period of implementation of the securities lending against cash, ie. since 15th Dec 2016. PSPP variable is the share of the bond outstanding held by the PSPP.

| | (1) SC repo rate | (2) SC repo rate | (3) SC repo rate |
|---|---|---|---|
| PSPP | -0.781*** | -0.555*** | -0.548*** |
| | (0.145) | (0.141) | (0.154) |
| Excess liquidity (excl. MRO and LTRO) | | -0.0219*** | -0.0218*** |
| | | (0.00265) | (0.00267) |
| MRO and LTRO | | -0.0539*** | -0.0530*** |
| | | (0.00676) | (0.00686) |
| GC Pooling | | 0.644*** | 0.642*** |
| | | (0.0394) | (0.0398) |
| End-of-month | | -1.757*** | -1.753*** |
| | | (0.540) | (0.543) |
| end-of-quarter | | -1.155** | -1.211*** |
| | | (0.436) | (0.437) |
| Last day of maintenance period | | 0.00110*** | 0.00103*** |
| | | (0.000144) | (0.000140) |
| VSTOXX volatility | | -0.0201*** | -0.0166*** |
| | | (0.00244) | (0.00214) |
| CDS France | | 0.0313*** | 0.0319*** |
| | | (0.00908) | (0.00925) |
| CDS Italy | | -0.0105** | -0.0102** |
| | | (0.00498) | (0.00471) |
| CDS Spain | | 0.0517*** | 0.0513*** |
| | | (0.00500) | (0.00494) |
| Swap OIS 5-Year | | 1.343*** | 1.350*** |
| | | (0.490) | (0.480) |
| Month | | -0.0825*** | -0.0778*** |
| | | (0.0106) | (0.0108) |
| Day | | 0.0473*** | 0.0475*** |
| | | (0.0105) | (0.0105) |
| SLF cash dummy | | 0.352*** | 0.443*** |
| | | (0.106) | (0.0867) |
| Bond FE | Yes | No | Yes |
| Country-Bucket-Time FE | Yes | No | No |
| $R^2$ | 0.512 | 0.047 | 0.049 |
| Observations | 201855 | 201580 | 201572 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Table 7: Effect of PSPP purchases on SC repo rates, Robustess tests

This table shows the impact of the ratio of the nominal amount bought to the total outstanding, on "Spot-Next" SC repo rates. We change the size of the sample to investigate if our results are robust. The first and second column are done respectively without the first quarter and the first semester of 2015. The third and the fourth column are run with the outliers and linkers. PSPP variable is the share of the bond outstanding held by the PSPP.

|  | (1) SC repo rate | (2) SC repo rate | (3) SC repo rate | (4) SC repo rate |
| --- | --- | --- | --- | --- |
| PSPP | -0.755*** | -0.749*** | -0.757*** | -0.896*** |
|  | (0.137) | (0.145) | (0.129) | (0.177) |
| Bond FE | Yes | Yes | Yes | Yes |
| Country-Bucket-Time FE | Yes | Yes | Yes | Yes |
| $R^2$ | 0.532 | 0.574 | 0.796 | 0.513 |
| Observations | 168936 | 117194 | 208574 | 186617 |

Standard errors in parentheses, clustered at the maturity bucket-country level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

# References

Adrian, T., Begalle, B., Copeland, A., and Martin, A. (2013). Repo and Securities Lending. In *Risk Topography: Systemic Risk and Macro Modeling*, NBER Chapters, pages 131–148. National Bureau of Economic Research, Inc.

Afonso, G. and Lagos, R. (2015). Trade Dynamics in the Market for Federal Funds. *Econometrica*, 83:263–313.

Armenter, R. and Lester, B. (2017). Excess Reserves and Monetary Policy Implementation. *Review of Economic Dynamics*, 23:212–235.

Arrata, W. and Nguyen, B. (2017). Price impact of bond supply shocks: Evidence from the eurosystem's asset purchase program. *Banque de France Working Paper Series no. 623*.

Baklanova, V., Caglio, C., Cipriani, M., and Copeland, A. M. (2017). The use of collateral in bilateral repurchase and securities lending agreements. Technical report, Federal Reserve Bank of New York.

Bech, M. L. and Klee, E. (2011). The mechanics of a graceful exit: Interest on reserves and segmentation in the federal funds market. *Journal of Monetary Economics*, 58(5):415–431.

Bech, M. L. and Malkhozov, A. (2016). How have central banks implemented negative policy rates?

Berentsen, A., Kraenzlin, S., Müller, B., et al. (2015). Exit strategies and trade dynamics in repo markets. Technical report, Swiss National Bank.

Boissel, C., Derrien, F., Örs, E., and Thesmar, D. (2014). Sovereign crises and bank financing: Evidence from the european repo market. *Manuscript, HEC Paris*.

Bottazzi, J.-M., Luque, J., and Páscoa, M. R. (2012). Securities market theory: Possession, repo and rehypothecation. *Journal of Economic Theory*, 147(2):477–500.

Bucalossi, A. and Scalia, A. (2016). Leverage ratio, central bank operations and repo market.

Buraschi, A. and Menini, D. (2002). Liquidity risk and specialness. *Journal of Financial Economics*, 64(2):243–284.

Carlson, M., Duygan-Bump, B., Natalucci, F., Nelson, B., Ochoa, M., Stein, J., and den Heuvel, S. V. (2016). The Demand for Short-Term, Safe Assets and Financial Stability: Some Evidence and Implications for Central Bank Policies. *International Journal of Central Banking*, 12(4):307–333.

Carpenter, S., Demiralp, S., Ihrig, J., and Klee, E. (2015). Analyzing federal reserve asset purchases: From whom does the fed buy? *Journal of Banking & Finance*, 52:230–244.

CGFS (2017). Repo market functioning. Technical report, Bank of International settlements.

Christensen, J. H., Krogstrup, S., et al. (2015). Transmission of quantitative easing: The role of central bank reserves. Technical report, Swiss National Bank.

Christensen, J. H. E., Lopez, J. A., and Shultz, P. (2017). Is There an On-the-Run Premium in TIPS? Working Paper Series 2017-10, Federal Reserve Bank of San Francisco.

Coeuré, B. (2017). Bond scarcity and the ecb's asset purchase programme. *Speech at the Club de Gestion Financiere d'Associes en Finance, Paris, 3 April 2017*.

Corradin, S. and Maddaloni, A. (2017). The importance of being special: repo markets during the crisis. Working Paper Series 2065, European Central Bank.

D'Amico, S., Fan, R., and Kitsul, Y. (2014). The scarcity value of Treasury collateral: Repo market effects of security-specific supply and demand factors. Finance and Economics Discussion Series 2014-60, Board of Governors of the Federal Reserve System (U.S.).

Duffie, D. (1996). Special repo rates. *The Journal of Finance*, 51(2):493–526.

Duffie, D. and Krishnamurthy, A. (2016). Passthrough efficiency in the fed's new monetary policy setting. In *Designing Resilient Monetary Policy Frameworks for the Future. Federal Reserve Bank of Kansas City, Jackson Hole Symposium.*

Dunne, P. G., Fleming, M. J., and Zholos, A. (2013). ECB monetary operations and the interbank repo market. Staff Reports 654, Federal Reserve Bank of New York.

ECB (2015a). Decision (eu) 2015/1574 of the european central bank. *Official Journal of the European Union.*

ECB (2015b). Money market survey 2015.

Ennis, H. M. and Keister, T. (2008). Understanding monetary policy implementation. *Economic Quarterly*, (Sum):235–263.

Fache Rousová, L. and Rodríguez Caloca, A. (2015). The use of securities holdings statistics (shs) for designing new euro area financial integration indicators. Technical report, Bank for International Settlements.

Faubert, V. and Sode, A. (2013). Are safe assets to become scarcer? *Tresor Eco no 177.*

Fernandez, R. (2017). European repo markets: Operating within a new normal. Technical report, Nomura European Rates Insights, 5 April 2017.

Ferrari, M., Guagliano, C., and Mazzacurati, J. (2016). Collateral scarcity premia in eu repo markets.

Fisher, M. (2002). Special repo rates: An introduction. *Economic Review-Federal Reserve Bank of Atlanta*, 87(2):27.

Fleming, M. J. and Garbade, K. (2004). Repurchase agreements with negative interest rates.

Fleming, M. J., Hrung, W. B., and Keane, F. M. (2010). Repo Market Effects of the Term Securities Lending Facility. *American Economic Review*, 100(2):591–596.

Frost, J., Logan, L., Martin, A., McCabe, P. E., Natalucci, F. M., and Remache, J. (2015). Overnight rrp operations as a monetary policy tool: some design considerations.

Fuhrer, L. M., Müller, B., and Steiner, L. (2017). The liquidity coverage ratio and security prices. *Journal of Banking & Finance*, 75:292–311.

Garratt, R., Martin, A., McAndrews, J. J., and Nosal, E. (2015). Segregated balance accounts. Staff Reports 730, Federal Reserve Bank of New York.

Greenwood, R., Hanson, S. G., and Stein, J. C. (2015). A Comparative-Advantage Approach to Government Debt Maturity. *Journal of Finance*, 70(4):1683–1722.

Greenwood, R., Hanson, S. G., and Stein, J. C. (2016). The federal reserve's balance sheet as a financial-stability tool. In *Designing Resilient Monetary Policy Frameworks for the Future," Jackson Hole Symposium: Federal Reserve Bank of Kansas City.*

Huh, Y. and Infante, S. (2016). Bond market liquidity and the role of repo.

Jordan, B. D. and Jordan, S. D. (1997). Special repo rates: An empirical analysis. *The Journal of Finance*, 52(5):2051–2072.

Kandrac, J. and Schlusche, B. (2016). Quantitative easing and bank risk taking: evidence from lending.

Klee, E. C., Senyuz, Z., and Yoldas, E. (2016). Effects of Changing Monetary and Regulatory Policy on Overnight Money Markets. Finance and Economics Discussion Series 2016-084, Board of Governors of the Federal Reserve System (U.S.).

Koijen, R. S., Koulischer, F., Nguyen, B., Yogo, M., et al. (2017). Euro-area quantitative easing and portfolio rebalancing. *American Economic Review*, 107(5):621–627.

Kreicher, L., McCauley, R. N., and McGuire, P. (2013). The 2011 fdic assessment on banks managed liabilities: interest rate and balance-sheet responses.

Krishnamurthy, A. (2002). The bond/old-bond spread. *Journal of Financial Economics*, 66(2-3):463–506.

Levels, A. and Capel, J. (2012). Is collateral becoming scarce? evidence for the euro area. *Journal of Financial Market Infrastructures*, 1(1):29–53.

Mancini, L., Ranaldo, A., and Wrampelmeyer, J. (2016). The euro interbank repo market. *Review of Financial Studies*, 29(7):1747–1779.

Martin, A., McAndrews, J., Palida, A., and Skeie, D. (2013). Federal reserve tools for managing rates and reserves.

Mersch, Y. (2017). Ructions in the repo market – monetary easing or regulatory squeezing? *Speech by Yves Mersch, Member of the Executive Board of the ECB, at the GFF summit, Luxembourg, 26 January 2017.*

Munyan, B. (2015). Regulatory arbitrage in repo markets.

Poole, W. (1968). Commercial Bank Reserve Management In A Stochastic Model: Implications For Monetary Policy. *Journal of Finance*, 23(5):769–791.

Singh, M. (2011). Velocity of pledged collateral: analysis and implications.

Spies, M. and Sian, H. (2017). Pspp or regulations: What's driving repo markets? Technical report, Citi, Euro Rates Strategy Focus, 23 March 2017.

Stein, J. C. (2012). Monetary policy as financial stability regulation. *The Quarterly Journal of Economics*, page qjr054.

Vari, M. (2015). Implementing Monetary Policy in a Fragmented Monetary Union. CEPREMAP Working Papers (Docweb) 1516, CEPREMAP.

# A    Regulation and the repo market

Regulations of financial institutions and financial markets may impact the repo market in many ways: by incentivizing financial institutions and other market participants to hold "safe assets" on balance sheets, by limiting collateral reuse, by restricting or penalizing repo leverage. In the following sections, we detail some of these regulations and their likely impact on the repo market functioning.

## A.1    Regulatory demand of high-quality liquid assets

Some regulatory constraints incentivize financial intermediaries to hold bonds of the highest quality (in terms of credit and liquidity) and thus might prevent them from lending these bonds out on the repo market.

- The Liquidity Coverage Ratio (LCR), which is part of the Basel III regulations, forces banks to hold High Quality Liquid Assets (HQLAs), mostly government bonds. Its phasing-in started in 2015 and it will become fully effective in 2019. As of December 2016, the stock of HQLA assets held by European banks already equals 139.5% of LCR requirements. At the same date, about 2.5 trn EUR of assets are classified as HQLAs, so as of December 2016, banks are required to hold around 1.8 trn EUR of HQLAs under the LCR[33]. Collateral borrowed in a reverse repo transaction is counted in the stock of HQLA assets of a bank if it is eligible as such.[34] But, as underlined in Klee et al (2017), borrowing a HQLA asset via a reverse repo does not change the LCR ratio:*treatment of collateral in case of repo transactions for LCR purposes implies that lending in the repo market (in which the underlying collateral is in the HQLA category) has no effect on a bank's LCR*. Overall, the marginal effect of the LCR implementation is expected not to be material on repo rates in the US. The consequence of LCR ratios enforcement on HQLA assets expected returns in the US is studied in Duffie and Krishnamurthy (2016). Fuhrer et al. (2017) find that for the Swiss securities market, qualifying as a HQLA asset decreases on average the yield of a security by around 4 bps.

- The mandatory posting of collateral to fund initial margins (IMs) and variation margins (VMs) of OTC derivatives positions, as prescribed in the European Market Infrastruc-

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[33]https://www.eba.europa.eu/documents/10180/1720738/EBA+Report+of+CRDIV-CRR+Basel+III+monitoring+exercise+-+December+2016.pdf

[34]http://www.bis.org/publ/bcbs284.pdf

ture Regulation (EMIR), might also play a role. Such requirements entered into force in 2014. Margins collected by the Central Clearing Counterparties (CCPs) are subject to haircuts, which increase with their risk[35]. Participants are likely to post as margins their highest quality holdings, which will end up on the balance sheets of CCPs. While they are allowed to re-use IMs and VMs under certain conditions, it is in practice limited. Such assets are more likely to remain on their balance sheets.

## A.2   A limit on the re-use of repo collateral

'Re-use' is the activity performed on the repo market whereby agents having borrowed a security will lend it again. Re-use thus increases the supply of collateral on the repo market. Mutual Funds usually re-use the collateral they receive in the course of their securities lending and derivatives positions (the collateral mitigates the counterparty risk from those operations). The UCITS[36] V regulation of mutual funds, which was enforced in March 2016, restricts the way they can re-use the collateral they receive. Re-use is permitted only if a collateral asset of at least the same quality is borrowed in exchange. Such a regulation is thus likely to decrease supply of collateral on the repo market.

## A.3   Restrictions or costs on repo leverage

Other regulations impose a restriction or a cost on leverage, which can deter financial institutions from trading repo, because repo transactions increase bank's balance sheets.

- The new Money Market Funds regulation[37], which was first drafted by the European Commission in November 2013, was ratified in April 2017 by the European Parliament. It creates pressures on the demand for short term assets, to meet daily and weekly liquidity criteria. It also imposes restrictions in the use of repurchase agreements, as MMFs (which encompass UCITS as well as AIFs[38]) can only invest in repos up to a limit of 10% of their assets.

- The Leverage Ratio (LR) imposes capital requirements primarily based on the size, not on the risk exposure of banks' balance sheets. Under the LR, banks must have a minimum leverage ratio of 3% (that minimum starts to kick in only in 2018, but since

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[35]http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32012R0648&from=EN

[36]UCITS stands for 'Undertakings for Collective Investment in Transferable Securities'

[37]http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1131&from=EN

[38]AIFs stand for Alternative Investment Funds

banks have to publish their leverage ratio since 2015, the 3% threshold has become a market reference). The impact of the LR on the repo market is documented in (CGFS, 2017): *"repos lead to an expansion of bank's balance sheet, and therefore attract a capital charge for the intermediary under the leverage ratio. Banks can hence be expected to adjust prices or limit supply in response to this cost"*. To comply with the LR, we expect banks to scale down both repos and repo trades intermediation activities. Repo trades can still be netted, which removes them from the scope of the LR (Fernandez, 2017). The impact of the LR on banks' repo operations has already been documented in Baklanova et al. (2017) for US and UK markets. They find that the reduction in repo activity for dealers is stronger for safer collateral than for riskier collateral. For the euro area, CGFS (2017) stresses that *"activities with low risk weights are more likely to be affected by balance sheet constraints than by risk-weighted capital requirements"*.

## A.4 Window-dressing around reporting dates

In Europe, compliance with regulation is most of the time binding at specific dates, mainly month-ends, quarter-ends or year-ends. For instance, the LCR ratio has to be reported at month-ends, while under the LR, European banks must report balance sheets at quarter-ends. This can entice financial institutions to do some form of window-dressing around reporting dates (see for instance Munyan (2015), Duffie and Krishnamurthy (2016) Klee et al. (2016)). This would be consistent with end-of-quarters volatility that we observe in the repo market. Spies and Sian (2017) underline that *"banks have to report LCR ratios on a monthly basis which leads to heightened volatility in repo markets during the last days before a reporting date"*. They observe in US Money Market Funds data changes in volumes at quarter-ends, noting for European banks *"clear seasonality at end-quarter, as banks' activity as repo counterparty fell dramatically"*. CGFS (2017) states that in jurisdictions where banks' reporting occurs at quarter-ends, there are *"incentives for banks to contract their repo exposure on these dates, giving rise to short-lived but sharp spikes in repo volumes and prices"*. On year-ends, additional balance sheet constraints add to the more frequent requirements. A prominent example is the contribution of banks to the Single Resolution Fund (SRF). Each year, the contribution is calculated based on the size of banks deposits.[39]

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[39]http://www.europarl.europa.eu/RegData/docs_autres_institutions/commission_europeenne/swd/2014/0327/COM_SWD(2014)0327(PAR3)_EN.pdf