The Impact of CCPs' Margin Policies on Repo Markets

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Abstract

This paper empirically quantifies the impact of a change in initial margins applied by central clearing counterparties on the cost of funding in repo markets. We use a unique dataset on the General Collateral segment of Italy's MTS Repo market of centrally cleared transactions - where both the liquidity taker and the liquidity provider are required to post initial margins - between January 2011 and March 2012, at the height of the Sovereign debt crisis. The analysis shows that increases in the level of initial margins had a positive and significant effect on the cost of funding observed on this market. Such an impact is consistent across different model specifications.

JEL Classification: E43, G01, G10.

Keywords: repurchase agreements, central counterparties, margin policies.

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1 Introduction

Starting in mid-2007, heightened concerns about counterparty credit risk and increased demand for liquidity led to significant disruptions in money markets. After the 2007-2008 crisis, banks' financing activity in the euro area shifted to the secured segment of the money market in the wake of a severe impairment of the unsecured segment. Since then, despite a large number of monetary policy measures has been undertaken, the proper functioning of euro money markets has not been completely restored, and the preference for secured transactions continues to be widespread (see ECB 2014a).[1]

In the euro area, the secured segment currently represents the largest share of the money markets, with transactions increasingly cleared through central clearing counterparties (CCPs). As such practice is not mandatory, it is likely to reflect the fact that in secured transactions too, and especially in times of heightened volatility, market participants are concerned with counterparties' creditworthiness (see CPSS 2010).[2]

In response to the growing reliance on central clearing, authorities have required CCPs to strengthen their risk monitoring and management systems, thereby enhancing their resilience (see CPSS-IOSCO 2012; EMIR 2012). Following this regulatory push, as well as increased volatility in Italian government bonds prices, the two CCPs active on the Italian repo market have moved to revise their initial margin policy in a more conservative direction. In centrally cleared repo, initial margins are paid by both parties (i.e. liquidity taker and liquidity provider), with the aim of providing the CCP with sufficient resources to mitigate potential risks. Modifications in margin policy both upward and downward, can have procyclical effects. While margin increases are expected to strengthen CCPs' resilience, they can also

[1]Recent data on the euro money markets indicate that trading on secured markets continues to account for the largest share of money market transactions, with cumulative turnover in the secured segment being almost 10 times the volume in the unsecured segment (see ECB 2014a). The estimated outstanding volume of repos and reverse repos currently amounts to about EUR 5.5 trillion (see ICMA 2015), a number comparable with the estimate available for the United States of about USD 5.5 trillion (see Copeland et al. 2012). The two markets however look quite different in terms of microstructure, infrastructure and financial operators active (ICMA 2014; FSB 2012; ECB 2012). In contrast to the United States, where most repo transactions are part of the shadow banking system (see Acharya and Öncü 2012), the majority of euro repo transactions are conducted in the interbank market, reflecting the dominating role of banks in the European financial sector. Moreover, the largest part of interbank repo transactions in the euro area is centrally cleared (see ECB 2014a).

[2]Centrally cleared contracts currently represent about 70% of all repo transactions (see ECB 2014a). As such practice is not mandatory for market participants, it is likely to reflect the fact that in secured transactions too, and especially in times of heightened volatility, market participants are concerned with counterparties' creditworthiness (see CPSS 2010).

determine disruptive second-round effects on the underlying markets.[3] Similarly, downward changes might prove procyclical, fostering leverage growth and the build-up of risks in the financial system.[4] Despite this broad agreement by academics and policymakers on the procyclical effects of margin changes, the limited availability of detailed data on repo markets has somehow constrained the extent of the analysis.

In this paper, we explore the impact of CCPs' initial margin policies on the cost of funding in repo markets, drawing on an extensive transaction-level data set on general collateral trades (GC) executed on the Italian MTS Repo market during the period from January 2011 to March 2012. During the period considered, the most acute phase of the European sovereign debt crisis unfolded, with relative calm restored in money markets after the activation of the Eurosystem's Very Long Term Refinancing Operations (VLTRO). To the best of our knowledge, this is the first study that quantitatively assesses the impact of CCPs' initial margin policies on the cost of repo funding. Overall, our analysis attempts to contribute to the policy debate on the potential impact of regulatory reforms both in the field of financial market infrastructures and of securities financing transactions.

In what follows we first show the existence of a positive relationship between the cost of secured funding and initial margins in a simple and tractable theoretical framework. We then empirically test such finding, showing that initial margins have a significant and positive effect on the cost of funding observed on the GC segment of the Italian MTS Repo market, with an average impact of about 3 basis points for a 100 basis point variation in the initial margin.

We also find an heterogeneous and non-linear effect of margins on the repo funding, with an higher impact of margins for lower quantiles of the distribution in the cost of repo funding: a 100 basis point increase in the initial margin translates into a change in the cost of repo funding ranging between 7 and 1 basis points, respectively, for the lower and upper tail of the distribution. Although our estimates relie on simplifying assumptions, we contribute to the

[3]To limit procyclical effects, CCPs are requested to establish stable and conservative margins, as far as possible, calibrated to include stressed market conditions (see CPSS-IOSCO 2012). Nevertheless, the transition to a state where margins are stable and conservative might require upward adjustments, with potential procyclical effects.

[4]This is confirmed by the work of the Financial Stability Board (FSB) to introduce minimum haircut levels in repo trades (see FSB 2013; FSB 2014). Indeed, since the Great Financial Crisis, a common view is that, in bilateral transactions, the haircut levels observed before the crisis deepened likely contributed to a surge in leverage and asset prices, while their subsequent increases have exacerbated the crisis, generating harmful procyclical effects (see CGFS 2010).

growing literature on the functioning of repo markets, shedding light on the effect of initial margin policies.

2 Literature review

Following the Great Financial Crisis, academics and policymakers started to take a renewed interest in repo markets. While pre-crisis studies related more to asset pricing issues (see Duffie 1996; Jordan and Jordan 1997; Buraschi and Menini 2002), the most recent ones have adopted a financial stability perspective with special attention paid to the functioning of repo markets, as well as the role they played in the propagation of the crisis and their impact on financial stability. Much of this literature has focused on the effects that changes in margins and haircuts can have on financial markets. New insights have emerged about the potentially adverse consequences of secured funding, with a particular focus on procyclical liquidity and leverage cycles. In Brunnermeier and Pedersen (2009), when negative shocks hit, procyclical margins can contribute to a "destabilizing" effect on market liquidity. Valderrama (2015) argues that the correlation between asset returns and funding costs resulting from daily re-margining practices[5] may exacerbate systemic risk, and help to turn liquidity shocks into solvency shocks by shifting market risks from lenders to borrowers.[6] A number of complementary studies have expanded on this argument, discussing how margin requirements could be used as a macroprudential tool by policymakers to restrict risk-taking and the build-up of excessive leverage (Gai et al. 2011; Goodhart et al. 2012; Brumm et al. 2013; Stein 2012; Biais et al. 2012).

In contrast, empirical studies on repo markets have so far been limited, most likely due to the scarcity of granular data. Most of the empirical evidence is related to the US market, with few studies of other countries or regions. Gorton and Metrick (2012) show that, during the crisis, increasing concerns about the quality of the collateral used in the US repo market led to abrupt increases in bilateral margins, which dramatically reduced trading volumes ("run on

[5]Daily marking to market of the outstanding positions determines the recalibration of the margins ("re-margining"), possibly leading to additional margin calls.

[6]Other papers on this topic include Gârleanu and Pedersen (2011), Rytchkov (2014) and Acharya, Gale, and Yorulmazer (2011).

repo"). Krishnamurthy et al. (2014) claim that the run observed during the crisis resembled more a simple credit crunch than the analogue of a traditional bank run by depositors, as balance sheet-constrained dealers simply tightened the terms of trades by increasing margins.

In contrast to what happened in the United States, Mancini et al. (2014) show that the CCP-cleared euro repo market proved remarkably resilient during the financial crisis, and that, when backed by high-quality collateral, it also acted as a shock absorber as repo lending activity increased in line with risk perceptions, while spread, maturities and haircuts remained stable. [7] Moreover,the paper finds that central bank excess liquidity can negatively impact both repo rates - up to a saturation threshold (of approximately EUR 300 billion) - and repo volumes.[8] In contrast with that paper, Boissel et al. (2014) find that the perception in euro area markets on the protection offered by CCPs against sovereign stress changed over time. While in the period 2009-2010 market participants believed that CCPs offered full protection against sovereign stress in the repo market, in 2011, at the peak of the crisis, this belief changed, and CCP-intermediated repo markets turned to be vulnerable to sovereign risk. In addition, Boissel et al. (2014) find that repo rates responded to movements in sovereign risk, in particular at the peak of the crisis and in countries where the stress was more acute. The focus of Corradin and Maddaloni (2015) is instead on the market for special repos traded on the MTS trading platform: after controlling for supply-related variables, they find that specialness is affected by the amount of securities traded as "special" that is in effect accessible on the market. As already mentioned, the extensive use of CCPs by market participants is a very important aspect of the repo market, especially in the euro area. Following the crisis, a surge of academic interest on central clearing has been recorded, also because regulatory reforms in the area of OTC derivatives, as well as persistent risk-aversion, have shifted an increasing share of financial trades towards central clearing. Overall, the impact of CCPs on welfare and systemic risk is still unclear (see Coeuré 2014). While trading thorugh CCPs may provide benefits in terms of financial stability, by reducing, for example, direct counterparty risk (IMF

[7]The paper uses data on Eurex General Collateral pooling transactions. The GC pooling basket is based on the Eligible Assets Database (EAD), used by the ECB for open market operations. This basket enables the re-use of received collateral for refinancing. It comprises securities rated as at least upper medium grade (ie A-/A3), subject to a number of further restrictions. Additional analysis is performed relying on BrokerTec and MTS GC and special repo data.

[8]The availability of abundant liquidity, supplied on relatively attractive terms, promotes a "substitution effect" between private and public liquidity (see Bolton et al. 2009).

2010; Acharya and Bisin 2014), they may also impose sizeable costs related, among others, to the larger demand for collateral (Singh 2010) and the concentration of credit and operational risks. Much theoretical literature has focused on models aimed at analysing the optimal design of incentive-compatible clearing arrangements, highlighting the possible emergence of a trade-off between improved risk-sharing (between each market participant and the CCP) and moral hazard (Biais et al. 2012; Koeppl et al. 2012; Acharya and Bisin 2014). A recent study (see Abruzzo and Park 2014) has instead investigated the relationship between margin level changes and volatility in the futures market, finding that margins rapidly increase after volatility spikes, but do not suddenly release afterwards, thus implying non-linear, procyclical dynamics.

Our paper builds largely on the economic literature related to the functioning of repo markets. Nonetheless, given the relevance of CCPs, we also look at the role and incentives provided by CCPs to their members. In particular, our analysis attempts to merge the above mentioned streams of literature by exploring the links between CCPs' risk management policies and dynamics in repo markets. To this end, we use a comprehensive database on repo trading activity to quantitatively assess the impact of CCPs' initial margin policies on the cost of funding in repo markets. To the best of our knowledge, this is the first study that offers a quantitative investigation of this effect.

3 The repo market and the role of CCPs

A repo (also known as a "repurchase agreement") is a transaction between two parties, in which one party borrows cash from the other by pledging a financial security as collateral. Seen from a different perspective, a repo transaction implies the temporary sale of a security at a spot price and the agreement to buy back the same security at a specified price and date in the future; the difference between the spot and the forward prices defines the repo rate. In the repo markets, loans can be extended for different maturities, ranging from short (eg overnight, tom-next and spot-next repos) to longer terms (eg from one week up to one year). There are two types of repo contracts, distinguished by the assets used to secure the exchange of liquidity. In GC repos, the collateral is a security discretionally chosen among a large basket of bonds usually issued by central governments or corporates. By contrast, in special repos (SRs) liquidity is exchanged against a specific asset demanded as collateral. Different economic reasons drive investors' choice to trade in either one or the other segment: while GC repos are typically used to cover funding needs (cash-driven transactions), SRs usually provide for the temporary loan of specific bonds (security-driven transactions) and may be part of short-selling strategies. The rate on SRs is generally lower than the one on GC repos, reflecting the premium attached to a specific bond, because the cash-rich counterparty is willing to pay a premium to temporarily dispose of that particular security.

Repos on Italian government bonds can be traded electronically on Italy's MTS Repo platform. In GC transactions executed on this system, funds can be exchanged against any security included in a basket of Italian government bonds comprising the full range of Italian government issues; in these trades, the liquidity taker selects the security pledged as collateral within two hours following the conclusion of the trade. By contrast, in SRs, precisely determined Italian government bonds collateralise the exchange of funds.Following the crisis, trading on Italy's MTS Repo platform increased remarkably. In 2014, daily volumes on the market amounted, on average, to about EUR 84 billion (up from EUR 82 billion the year before); SRs accounted for the largest part (67%) of the contracts over the same period. Notably, over about 95% of these transactions were cleared through the use of the two CCPs active on this market, namely Cassa di Compensazione e Garanzia (CC&G) and the French LCH.Clearnet SA, used, respectively, by Italian and foreign financial institutions (see Banca d'Italia 2014b).[9]As already noted, market participants have made a larger use of the clearing services offered by CCPs in recent years due to regulatory developments as well as enduring risk aversion in financial markets (see CPSS-IOSCO 2012; EMIR 2012). The advantages that central clearing offers to market participants relate primarily to counterparty risk reduction and to cash and collateral savings through multilateral netting. Nonetheless, participating in a CCP entails some costs, such as annual participation fees, contributions to the default fund and the payment of initial and variation margins. In centrally cleared repo transactions, CCPs require both parties (ie the liquidity taker and the liquidity provider) to post initial

[9]This is the only case in the euro area where two CCPs have entered into an interoperability agreement to serve a common market (see Banca d'Italia 2014a; Banca d'Italia 2014b).

margins with the CCP on the net amount of the collateral due, with the aim of providing the CCPs with sufficient resources to mitigate potential risks (see Graph 1).[10] In contrast to bilateral trades where liquidity takers only pay haircuts, in CCP-cleared contracts, margins represent a cost for both liquidity takers and liquidity providers. In addition, participants may be asked, at least daily, to post variation margins following mark-to-market valuation of individual positions vis-à-vis the CCP.

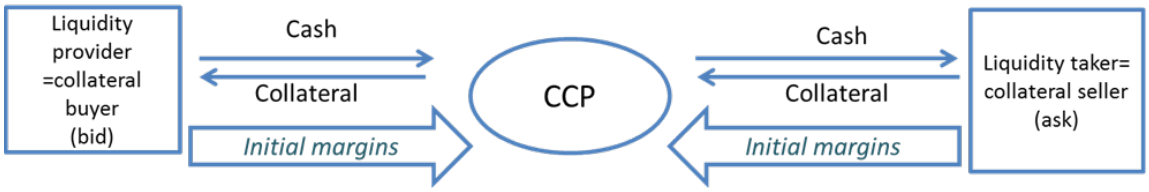

Figure 1: margins' provision in a CCP-cleared repo

Given the significant reliance of market participants on clearing services, the MTS Repo market is potentially sensitive to the risk management policies adopted by CCPs. In recent years, both CC&G and LCH have progressively refined their risk management policies following the regulatory push to enhance CCPs' resiliency. At the same time, the generalised increase in sovereign risks has led CCPs to raise their initial margins with a view to increasing their protection vis-à-vis their credit exposures to participants.

On 9 November 2011, in order to better manage sovereign risk, the risk management framework was made more responsive to the spread between Italian and European benchmark securities. As a consequence, the increase in initial margin requirements on positions collateralised by Italian government securities across all duration buckets ranged between 3.5% and 5%. These increases were partially reversed in December 2011 (see Graph 2). The remarkable margin change observed in late 2011 was associated with a spike in the cost of repo funding, which was especially driven by a sharp increase in the Italian repo rate. In the following sections, we first show - on theoretical grounds - that a causal relationship between margins and the cost of repo funding exists; then we empirically test and quantify it using data on the Italian MTS Repo market.

[10] CCPs use the margins posted by liquidity providers to cover themselves against the risks of: (i) collateral not being refunded; and (ii) insufficient cash to buy the collateral on the market. On the other hand, CCPs use the margins posted by liquidity takers to cover themselves against the risks of: (i) cash not being refunded; and (ii) the inability to realise the collateral on the market for the same amount.

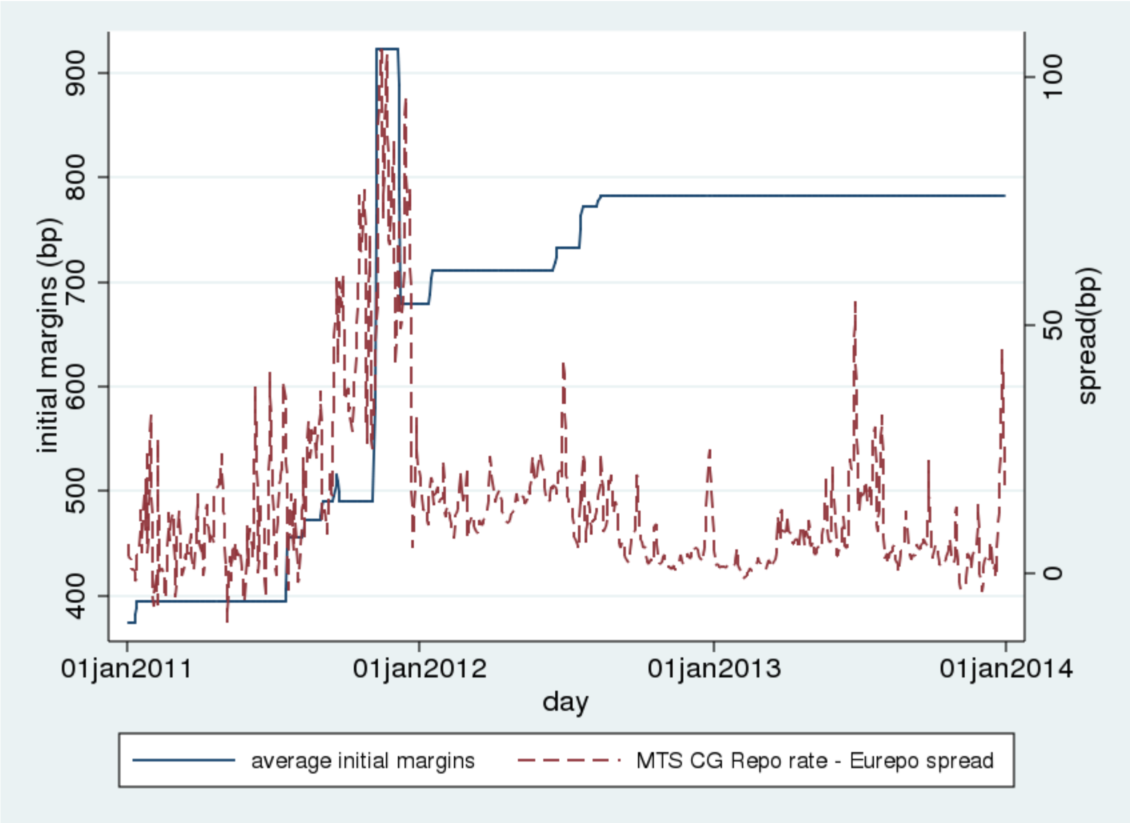

Figure 2: Average margins and spreads on the Italian Repo Market

Note: In the graph, a daily average of initial margins applied to different maturity buckets are plotted (solid blue line, left-hand scale) along with the daily average spread between MTS GC Repo rates and Eurepo (red dashed line, right-hand scale). Data are in basis points.

4 A model of margining

To see the link between margins and the cost of repo funding, we develop a stylized model of CCP cleared secured transactions. The main purpose of the model is to show that, in a repo market where initial margins are paid both by liquidity takers and providers, in a situation where the liquidity taker is subject to a tight collateral constraint an increase in margins leads to a higher cost of repo funding and to lower quantities exchanged. This was indeed the case for the Italian banking system in 2011, which displayed a positive net foreign debt position on the MTS repo market in 2011 (see Banca d'Italia 2014a). Note that in the model we are going to show a positive relationship between the margins and the repo rate, while in the subsequent empirical exercise we focus on the relationship between margins and the cost of funding (ie. the spread between the interest rate of the repo trade and the corresponding

Eurepo rate.[11]). Under the assumption of an invariant Eurepo rate, the rate and the spread would be perfectly collinear, thus an increase in the repo rate would fully translate into a higher cost of funding.[12]

The model lasts two periods, $t = 1, 2$, and involves two risk neutral agents, a "liquidity taker", T, and "liquidity provider", P.[13] The liquidity taker is endowed with K units of a risk free zero-coupon bond whose value in period 1 is 1 and whose gross return in period 2 is $R > 1$ per unit. There is no secondary market for the security, but we assume it can be pledged as collateral in a repo contract. The liquidity provider instead has a monetary endowment Y. The liquidity taker and provider differ also in their discount rates. In particular we assume that the liquidity taker is more impatient than the provider: $\beta^T > \beta^P$, with $\beta^P, \beta^T \in (0, 1)$.

The economy starts with no contracts in place. The agents enter into a repo contract in which the liquidity taker receives a cash amount $d > 0$ in period 1 and promises to repay $(1+r)d$ in period 2, where r is the repo rate of the contract.[14] We assume that exchanges are collateralized and take place through a CCP. It is also assumed that the liquidity taker cannot borrow more than the current value of the available collateral K net of the margin paid md, so that the borrowing constraint writes $d \leq K - md$. The existence of the borrowing constraint is due to the risk management policies of the CCP (see Section 3).[15] Both the liquidity taker and the provider have to post initial margins $m \in (0, 1)$ to the CCP, that are going to be rebated in period 2.

Therefore the problem for the liquidity taker is

[11]The Eurepo is the rate "*at which, at 11.00 a.m. Brussels time, one bank offers, in the euro-zone and worldwide, funds in euro to another bank if in exchange the former receives from the latter the best collateral within the most actively traded European repo market*". The range of maturities quoted by panel banks are the following: tomorrow-next, up to one month (i.e. one/two/three weeks), and one month and beyond (one/two/three/six/nine and twelve months).

[12]In the theoretical model there is no "benchmark" rate, as the only repo rate is the one on the contract. We could nonetheless introduce a reference rate, but this would not be affected by margin variations on the specific contract. Therefore, the results would seamlessly apply.

[13]We model agents' utility as linear, thus implying risk neutrality. This assumption is introduced in order to work with simple, closed-form, expressions. All the qualitative results of the model apply with any standard utility function.

[14]Despite both assets (the bond and the repo loan) being risk-free, the gross return on the bond R differs from the repo rate r because we assume the existence of the repo market but not of a secondary cash market for the bond. As a consequence, R embeds a liquidity premium that r doesn't include.

[15]An alternative assumption would be that the liquidity taker cannot borrow more than the value of the asset in period 2, net of the return accrued on d, i.e. $(1+r)d \leq RK - md$. This alternative assumption would lead to the very same results in terms of the impact of margins on rates and quantities exchanged.

$$
\begin{aligned}
&\max_{c_1^T, c_2^T} c_1^T + \beta^T c_2^T \\
\text{s.t.} \quad & c_1^T + md = d \\
& c_2^T + (1+r)d = RK + md \\
& d \leq K - md
\end{aligned} \tag{1}
$$

where $c_1^T, c_2^T > 0$ relate to the consumption of the liquidity taker either in period 1 or 2. The demand for repo funds is then easily derived. When the collateral constraint is slack, the Euler equation for the liquidity taker implies

$$
r^T = \frac{1-\beta^T}{\beta^T}(1-m). \tag{2}
$$

When the constraint is binding, the demand for repo funds is directly derived from (1), therefore

$$
d^T = \begin{cases} 0 & \text{if } r > r^T \\ [0, d^*] & \text{if } r = r^T \\ d^* & \text{if } r < r^T \end{cases} \tag{3}
$$

where $d^* \equiv \frac{K}{1+m}$. Demand is downward sloping and has kinks at points 0 and d^*. Note that r^T is negatively related with the margin paid: when margins increase, the liquidity taker seeks compensation - through a lower rate - to the decrease in consumption today (which is not fully compensated by consumption tomorrow, due to the discount rate).

From point d^* on, the demand of the liquidity taker is constrained by its collateral endowment and by the margin paid: any increase in margins shifts the constraint to the left, thus mechanically reducing the maximal amount of liquidity that can be borrowed by the liquidity taker.

In a similar vein, the problem for the liquidity provider is

$$\max_{c_1^P, c_2^P} c_1^P + \beta^P c_2^P$$
$$\text{s.t.} \quad c_1^P + d + md = Y$$
$$c_2^P = (1+r)d + md \tag{4}$$

with $c_1^P, c_2^P > 0$ In this case, the first order conditions w.r.t. d give us the supply of repo funds:

$$1 + m = \beta(1 + r + m) \tag{5}$$

This implies that:

$$r^P = \frac{1 - \beta^P}{\beta^P}(1 + m). \tag{6}$$

Hence the supply schedule writes:

$$d^P = \begin{cases} 0 & \text{if } r < r^P \\ [0, \frac{Y}{1+m}] & \text{if } r = r^P \\ \frac{Y}{1+m} & \text{if } r > r^P \end{cases} \tag{7}$$

where it can be noted that in this case - in contrast with the liquidity taker, but for the very same argument - an increase in margins leads to an upward shift of the horizontal part of the supply schedule: indeed when margins increase, the liquidity provider seeks compensation through the rate for the fact that he can lend less (and thus earn less in period 2).[16]

The effects of a shift in margins can be easily seen through a graphical representation of the equilibrium (see Graph 3). Suppose, for the sake of simplicity, that the equilibrium is at

[16] Note that to get an equilibrium with a strictly positive amount of funds traded we need $r^T \geq r^P$. This implies a restriction on parameters. More precisely, this requires that

$$r^T = \frac{1 - \beta^T}{\beta^T}(1 - m) \geq \frac{1 - \beta^P}{\beta^P}(1 + m) = r^P \tag{8}$$

or, after some manipulation

$$\frac{\beta^P}{\beta^T} \geq \frac{1 + m(1 - \beta^P)}{1 - m(1 - \beta^T)}. \tag{9}$$

point E: an increase in margins implies an upward shift in the rate at which funds are offered (bid), along with a reduction of the total funds available. At the same time, it will tighten the collateral constraint (1), thus shifting the vertical part of the demand backwards up to the point d', while the horizontal part will shift downwards, due to a reduction in the ask rate. The new equilibrium will be at point E', thus implying a lower quantity of funds exchanged at a higher rate after the increase in initial margins.[17]

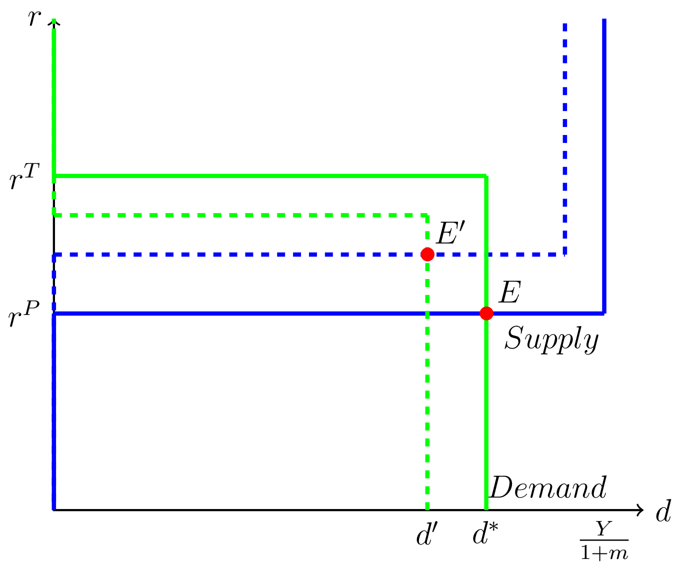

Figure 3: Equilibrium in the repo market

5 Data and empirical analysis

The main data set is constituted by GC repo transactions executed on Italy's MTS Repo trading platform, from 3 January 2011 to 3 March 2012; this information is collected by the Bank of Italy for supervisory purposes (see Table 1). We focus on this period because it was associated with the most acute strains in repo markets due to the eruption of the European Sovereign debt crisis. As can be seen in Graph 2, spreads on the Italian Repo market significantly increased from an average of 7 basis points in January 2011 to the peak of more than 100 basis points in november 2011. After the activation of the two Very Long Term Refinancing Operations (VLTRO) by the Eurosystem, spreads retraced to pre-crisis

[17]A crucial assumption underlying the above result is that $K < Y$. In other words, we assume that the liquidity provider has enough resources to fully fund the liquidity taker. Such an assumption seems to fit rather well the situation on the MTS Repo market back in 2011, where - on aggregate - Italian banks where in liquidity need and were funded by liquidity rich foreign istitutions.

levels. Also, more frequent margins revisions were observed in this period than in any other. Hence, we chose as end period the day of the allotment of the second VLTRO.

The data set contains transaction-level information, including the trading volume, the repo rate, the collateral and the maturity of the contract; it also details whether the contract is CCP-cleared and which party provided the service (ie CC&G or LCH). Italian government securities only are eligible as collateral to secure transactions on this market; BTPs and BOTs account for the highest share of bonds pledged.[18] We focus on contracts with a one day maturity, which represent more than 94% of the trades concluded on MTS Repo during the considered period (see Table 1).

In our setting, the cost of funding on the Italian MTS Repo market is measured using the spread between the Italy's MTS GC rate and the Eurepo rate. The use of spreads is not new in this literature, though the definition has been formulated according to the purpose of the analysis (Taylor and Williams 2009 and Mancini et al. 2014). In our case, the spread measure intends to capture the differential cost of financing repo transactions by making use of Italian government bond collateral, rather than of the "*best collateral actively traded on European repo market*". In addition, this definition removes aggregate factors potentially affecting both rates, such as the expected or actual changes in official monetary policy rates.[19] In fact, since the beginning of 2012, unconventional monetary policy measures, as well as the cuts in policy rates, have contributed to the gradual fall observed in both the Italian repo and the Eurepo rates (see Graph 4).

Our dependent variable is constructed as follows:

$$s_{i,t} = rate_{i,t} - Eurepo_t \tag{10}$$

where $rate_{i,t}$ is the rate negotiated on contract i, executed on the Italy's MTS Repo market on day t, while $Eurepo_t$ is the Eurepo rate quoted on day t of the corresponding maturity. Both rates refer to GC repo trades. Three caveats apply to the above-defined measure. First,

[18] BTPs are medium/long-term treasury bonds, while BOTs are short-term securities with maturities up to one year.

[19] The traditional interest rate channel ensures the pass-through of monetary policy decisions to short-term money markets; in the case of secured markets, this mechanism is enhanced by the fact that the Eurosystem's credit operations are close substitutes for repo markets.

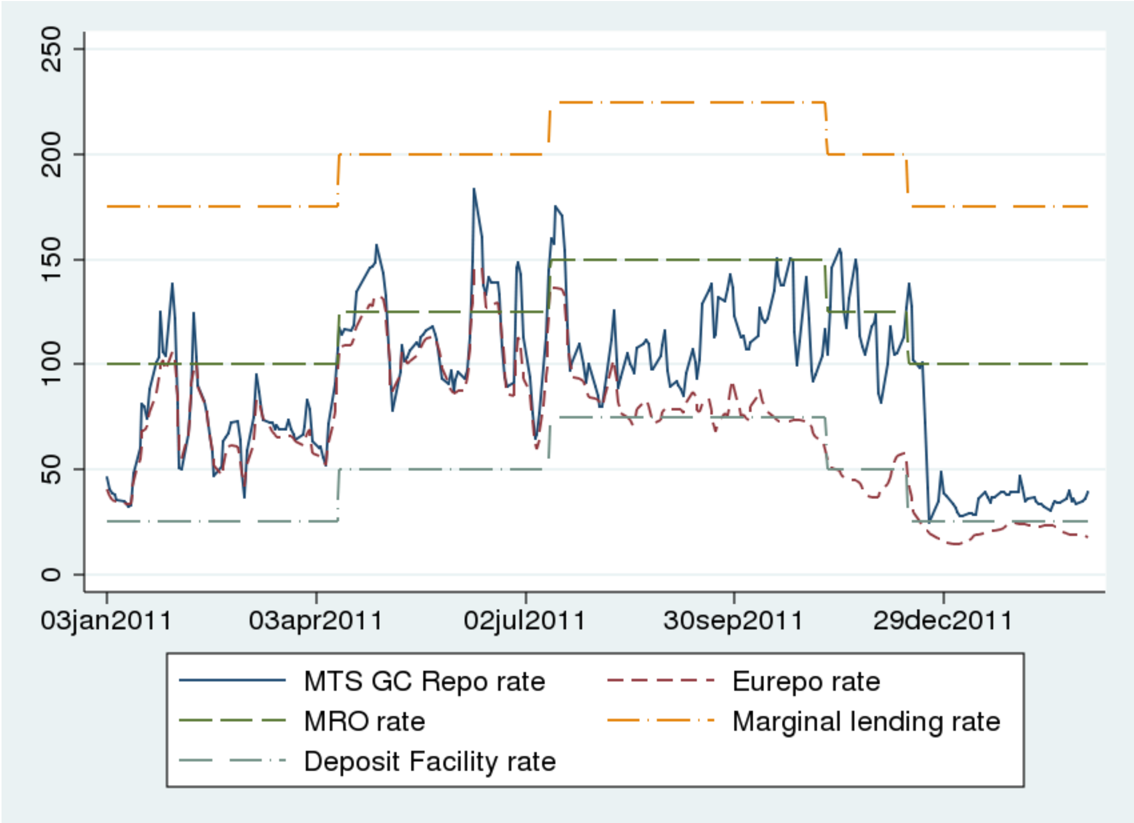

Figure 4: MTS Repo Rate, Eurepo and Monetary policy Rates

Note: In this graph, the daily average of the repo rate for the tom-next maturity is plotted along with the Eurepo rate for the same maturity bucket and the ECB policy rates (daily data; basis points).

the Eurepo is a offer-rate only which is compared with effectively traded rates that could stem either from a bid or an ask proposal. Second, submitted Eurepo rates may correspond to either bilateral or centrally cleared transactions, while for $rate_{i,t}$ we consider only the latter. Third, the Eurepo rate is a benchmark rate for the whole euro zone corresponding to the best quotes daily submitted by a panel of banks, while we take into account rates effectively negotiated on a single market by all participating banks.[20] Although this measure may present some bias, it is, in our view, the best approximation available for our purposes. As an alternative to the Eurepo rate, we have also used the RepoFundsRate, which is an index computed from effective repo trades, secured by general or special collateral, executed

[20]We can not exclude that variation in Eurepo rates could also reflect movements in CCP margins. To the extent that there might be positive correlation in margin changes throughout CCP-cleared European repo markets backed by Italian government securities, the use of a spread as a dependent variable could hide some confounding factors. However, this potential bias is, in our view, mitigated by the fact that Eurepo rates reflect not only centrally cleared transactions but also bilateral ones, for which this correlation bias could admittedly be negligible. In addition, given that it is set with reference to the "best collateral actively traded on the market", and not to a specific market backed by Italian collateral, it is reasonable to expect lower volatility.

on either the BrokerTec or the MTS platform. All eligible trades are centrally cleared and maturities are short-term only (overnight, tom-next or spot-next). In this case too, there is a certain degree of approximation deriving from the use of an index.[21] As will be shown in the following sections, the results of the empirical analysis are robust to the choice of the index. The evolution of the repo spread, computed as the difference between the repo rate and alternatively the Eurepo and the RepoFundsRate is represented in Graph 5. The Graph reports a daily average of the spreads.

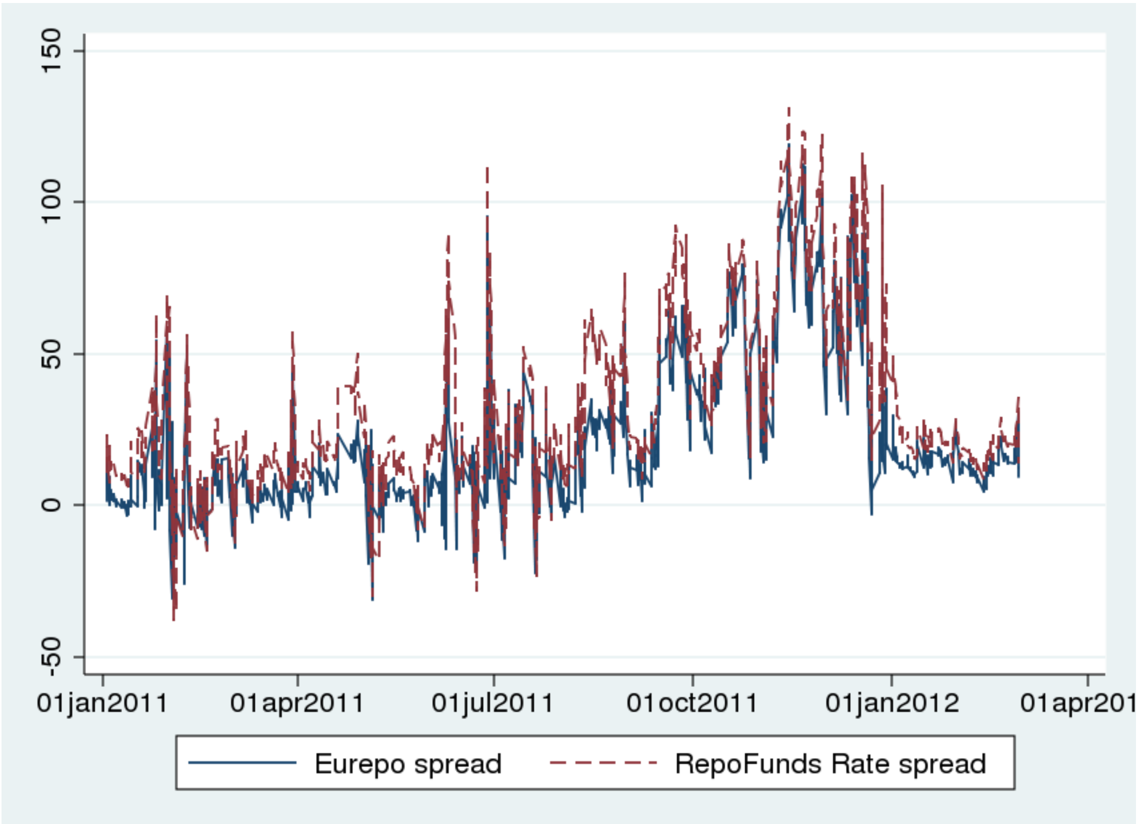

Figure 5: Spreads MTS Repo - Eurepo

Note: In the graph, the average MTS Repo Rate-Eurepo spread is plotted for the average one-day maturity (tom-next, spot-next and overnight, blue solid line) and the average MTS Repo Rate-RepoFunds Rate spread (red dashed line). Data are in basis points.

The two series display almost identical dynamics: a gradual increase can be seen in the second half of 2011, followed by a relatively sharp contraction at the beginning of 2012. Over the period considered, the average Eurepo spread variable, weighted by the volume and the maturity of the contract, is equal to 21 basis points (see Table 2).

[21]More precisely, we constructed a weighted average of the RepoFundsRate for Germany and France, using the volumes exchanged as a weight.

Our empirical approach implies regressing spreads $s_{i,t}$ on initial margins and on a broad set of explanatory variables. For the purpose of our analysis, we select only CCP-cleared contracts, with a onde-day maturity and a corresponding Eurepo rate(see Table 1)[22] Overall, we have a total of 129,235 trades, reaching an average daily trading volume of EUR 20 billion; cross-border transactions, which make use of the interoperability agreement between CC&G and LCH, account for the largest share of the monthly average of daily volumes.

We estimate a reduced-form baseline equation, which reads as follows:[23]

$$s_{i,t} = \alpha + \beta_1 mar_t + \beta_2 X_{t-1}^{mkt} + \beta_3 X_{i,t}^{repos} + \varepsilon_{i,t} \tag{11}$$

where:

- mar_t is the daily average level of margins weighted by the outstanding government debt amount for each bucket of duration. In a GC repo, the liquidity provider concludes the contract in the uncertainty of the exact security that she will receive as collateral and thus of the exact margin level that she will have to pay. Indeed, following the conclusion of the contract, the liquidity taker has a time span of two hours to select the specific security to guarantee the transaction. In this light, we introduce in the regression an average margin across maturity buckets, which is not contract-specific, but is intended to represent a proxy for the expectation of the liquidity provider about the initial margin to be paid.[24]

- X_{t-1}^{mkt} is a vector of variables capturing aggregate risk and, specifically, credit and liquidity risk, pointing ultimately to collateral quality uncertainty. To avoid co-movement

[22] Eurepo rates for overnight and spot-next contracts are not quoted. Nonetheless, we interpolate these rates from the official quotes provided on T/N maturity. Therefore the following maturities are considered in the analysis: overnight, tom-next and spot-next.

[23] It is recalled that $s_{i,t}$ represents the spread negotiated on contract i, executed on the Italy's MTS Repo market on day t; fixed effects are introduced at the level of liquidity provider. Descriptive statistics are reported in Table 2.

[24] The amount of initial margin to be paid depends on the duration of the security received as collateral; it is computed considering the net exposure in the correspondent duration bucket. Each trade triggers a change in the net exposure of one duration bucket and consequently an initial margin call. However, given the liquidity provider's uncertainty of what collateral she is going to receive and of the duration bucket on which her net exposures will change, we simplify our setting considering the impact of initial margins directly on individual transaction rates.

between spreads and aggregate risk indicators under the same shocks, we consider the latter lagged by one day. To avoid correlation between the average margin level and the aggregate risk vector, we discard risk measures that are considered by the two CCPs' joint margining methodology. Our measure of credit risk relies on the methodology developed by Gilchrist and Mojon (2014) and focuses on the Italian banking system.[25] In comparison with alternative market-based credit risk indicators (eg CDS spreads and iTraxx), this measure builds on a very large cross section of issuers, thus providing a more informative indication of financial distress. Furthermore, to control for liquidity risk on Italian financial markets, we make use of a systemic indicator developed at the Bank of Italy (see Iachini and Nobili 2014). This measure, ranging between 1 and 0, builds on a set of market variables selected to capture the intensity of liquidity distress in the most important segments of the Italian financial markets (the equity and corporate market, the Italian government bond market and the money market). The dynamics of the indicators are shown in Graph 6. Both credit and liquidity risk on the Italian financial markets increased sharply in the second half of 2011, gradually reducing thereafterOver the period considered, the correlation between the two indicators is high and significant (0.85; Table 3), although they reflect different phenomena on financial markets. Indeed, although correlation across the whole sample is strong, the dynamics of the two indicators tend to diverge in subsamples. To see this, in Graph 7 we plot rolling-window correlations among the two variables. It can be seen that in several occasions there was no (or even negative) correlation between the two variables. We also experimented with alternative indicators of riskiness and market volatility (VIX, CISS index etc) confirming the robustness of our estimates.[26]

- $X_{i,t}^{repos}$ is a vector of variables capturing market conditions affecting the repo market in each day, as well as idiosyncratic features for each contract. In particular, we consider the following variables: (i) the excess liquidity for the euro area, computed as the sum

[25] In Gilchrist and Mojon (2014), the measure for the credit spread is constructed at the bond level as the yield difference between corporate bonds and German Bund zero coupon bonds of the same maturity. These bond-level credit spreads are then aggregated to obtain credit risk indices at both sector and country level. The updated time series can be found at www.banque-france.fr/en/economics-statistics/research/working-paper-series/document/482-1.html.

[26] Results are available on request.

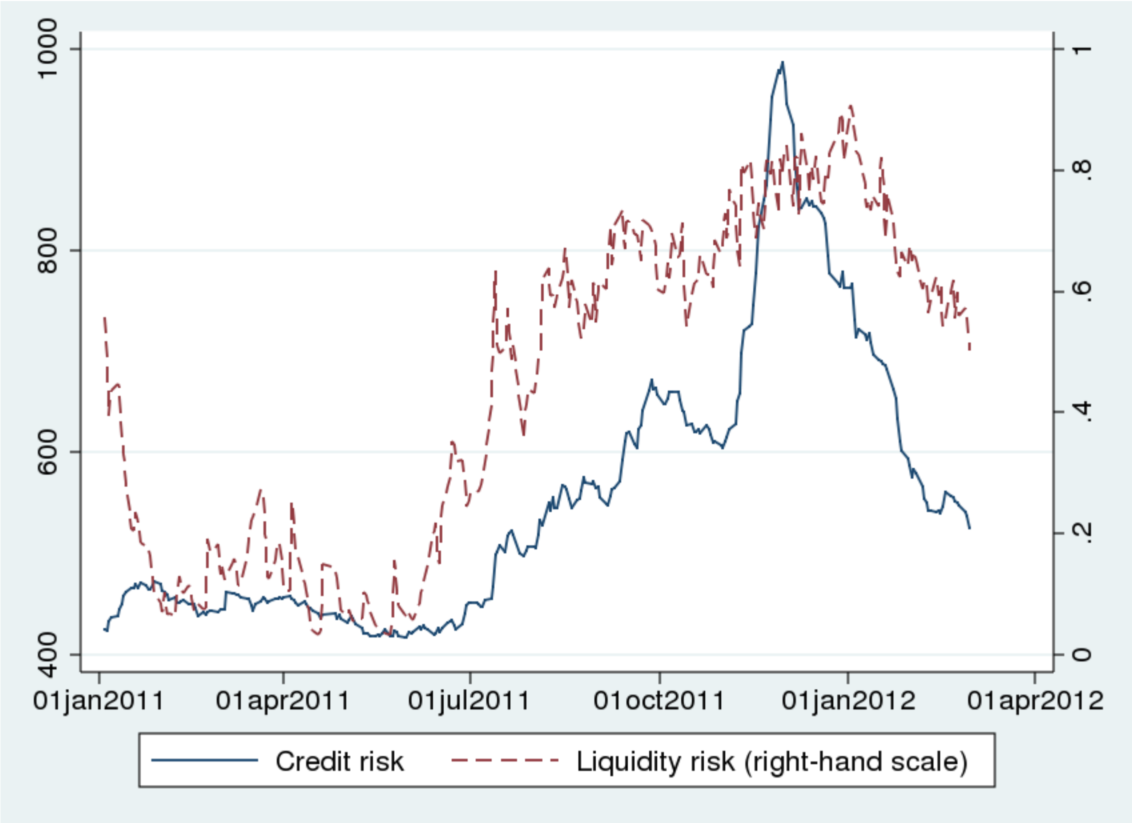

Figure 6: Credit risk and liquidity indicators

Note: In the graph, the Gilchrist and Mojon (2014) credit risk indicator for the Italian banking sector (blue solid line, per cent left-hand scale) is plotted along with the Iachini and Nobili (2014) systemic liquidity indicator for the Italian financial markets (red dashed line, right-hand scale).

of the deposit facility net of the recourse to the marginal lending facility, plus current account holdings in excess of those contributing to the minimum reserve requirements (see ECB 2014b); and (ii) the dummy variables capturing potential idiosyncratic pressure in liquidity markets to account for spikes in risk premia (Italian fiscal due dates, the end-of-month and end-of-quarter window-dressing effects). We also add a dummy for the end of maintenance period and a dummy that takes value one if the liqidity provider initiates the contract. As an additional control related to the market we include the total volume of contracts exchanged during the day.

In theory, one may want to introduce fixed effects controlling for idiosyncratic features of each agent in the market. This would in principle imply an interaction in each contract of a dummy for the liquidity provider with a dummy for the liquidity taker. In practice such an approach may work only in a market with very few agents; when the number of agents increases, the number of interactions grows at an exponential pace, thus leading to possible

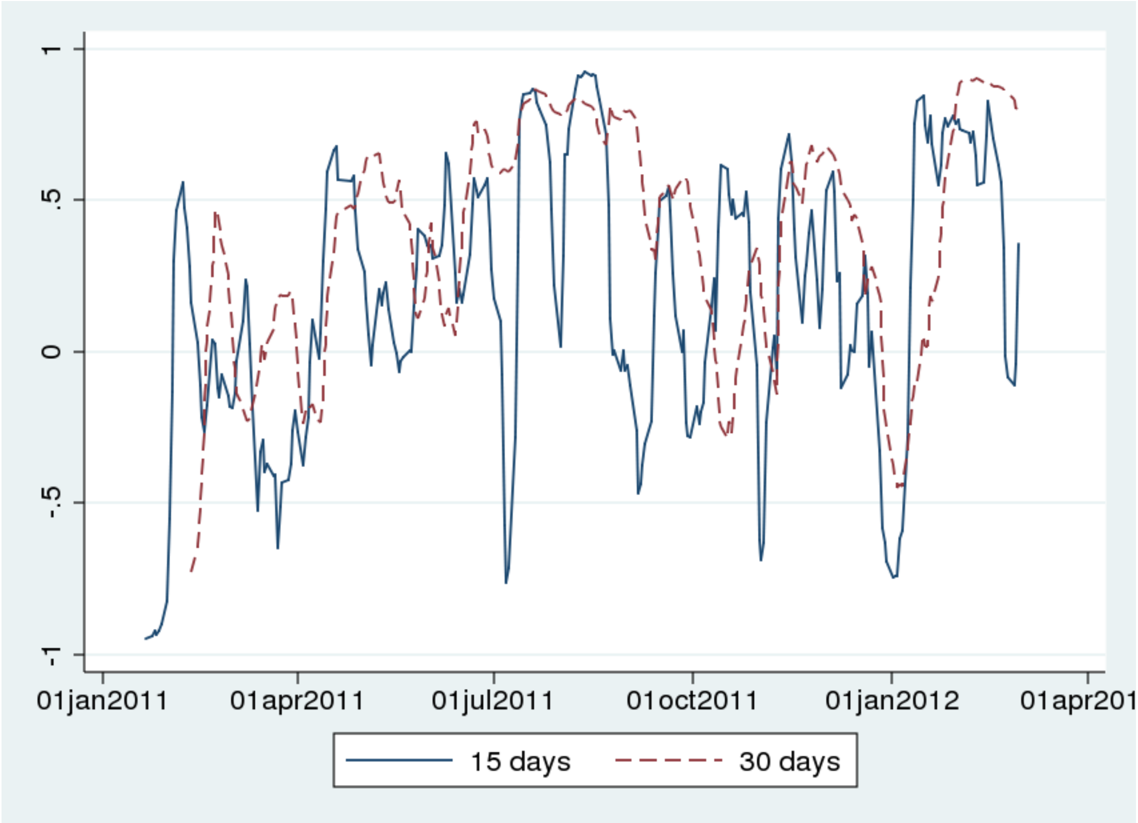

Figure 7: Correlation between credit risk and liquidity risk indicators

Note: The graph depicts the 15-day rolling-window correlation (blue solid line) and the 30-day rolling-window correlation (red dashed line) between the credit risk indicator and the liquidity indicator.

estimation biases. In addition, it is noted that exchanges are conducted anonymously, thus making the interaction less affected by the idiosyncratic features of market participants. We therefore opted for not introducing fixed effects at all. We later perform regressions with fixed effects both at the liquidity taker and provider level but this does not significantly affect our results.

It is worth stressing that we consider only centrally cleared transactions; hence, bank-specific features are not included, given that, in effect, idiosyncratic counterparty risk is not a concern as trades are concluded anonymously. We acknowledge that bank-specific features, linked, for instance, to liquidity surplus or deficits corresponding to idiosyncratic conditions, may - in principle - affect the bidding behaviour adopted by banks on the trading platform. However, as shown in the following section, various experiments with fixed effects at the bank level indicate that, in practice, bank-specific features do not play a major role. Also, the use of low-frequency balance sheet data does not necessarily help to explain high-frequency data from the market. In any case, the use of fixed effects at the counterparty level should provide some reassurance that the specification adopted somehow controls for bank-specific features.

We first estimate a linear panel model with fixed effects and cluster-robust standard errors (ie adjusted for both serial correlation and heteroskedasticity). In a subsequent exercise, we run quantile panel regressions to explain the distribution corresponding to the 10th, 25th, 50th, 75th and 90th quantile, using all the explanatory variables as in the baseline regression. The purpose of this analysis is to better gauge how explanatory variables are related to the distribution of our spread measure.

6 Results

6.1 Baseline regressions

In this section, we illustrate the results obtained from the panel regressions described in Equation 11. In Table 4, we report the results of our baseline regressions by making use of OLS. We first perform a basic regression without considering margins and other variables, such as the total volumes exchanged in a day or the duration of the contract. We then extend the regression by introducing margins and additional controls. Over the period considered a 100 basis point increase in the level of initial margin translates into a significant and positive change in the "repo rate-Eurepo spread" of about 3 basis points. As expected, systemic risk indicators have a positive and significant effect on our dependent variable. In particular, the analysis suggests that the credit risk indicator has a relevant impact, as an increase of 100 basis points corresponds to about a 12 basis point increase in the cost of repo funding. In addition, the systemic liquidity indicator has a positive and significant impact. The impact of liquidity is also captured by a variable linked to the level of excess liquidity in the euro area with a negative sign; in particular, a liquidity injection of EUR 100 billion into the system reduces the cost of funding by about 6 basis points. The inclusion of variables capturing potential idiosyncratic pressures in liquidity needs (end-of-month, end-of-quarter, end of maintenance period and fiscal-due-date dummies) exerts, instead, a significant and upward impact on the cost of funding. The effect observed at the quarter-end is consistent with some anecdotal evidence collected on the markets.[27] Also, the dummy on the provider is positive and significant, implying that if a liquidity provider initiates a contract, the spread on that specific contract will be about 4 basis points higher than a contract initiated by a liquidity taker. Finally, we consider a number of variables directly related to the daily activity observed in the repo market. In particular, we find that a higher trading volume exchanged on the MTS repo market is associated with a lower funding cost faced by market participants on that market, thus suggesting the existence of a liquidity premium.

Overall, we find that the variables selected provide a good fit of the data, with the adjusted R-squared of about 60% in the richest specification, and most of the variables being significant at a level of 1%, with rather stable coefficients across specifications. Note that the inclusion of initial margins in the specification does not affect the sign and magnitude of the other coefficients, while it slightly improves the explanatory power of the model. Also, all the above results are overall confirmed if one makes use of the RepoFunds rate as a benchmark for constructing the repo spread.

6.2 Robustness checks

In this section, we perform several robustness checks both with respect to both the specification of the model and to data sampling. The results found in the baseline regressions will overall be confirmed.

6.2.1 Endogeneity

To exclude the possibility that the findings are biased by potential endogeneity between the spread and the margin, we adopt a two-stage approach, where we first regress the margin on appropriate instruments and then replace the fitted value of the margin in the baseline regression. The concern is that the residuals of our baseline regression might not be orthogonal to mar_t and might therefore co-move with the margin in case of shocks, leading to an overestimation of the impact of margins on the spread. More precisely, as instrumental variables we take the mean of mar_t across the previous 15 trading days and two measures of market

[27] For example, at the end of the first semester of 2013, the average overnight weighted rate dropped from 0.51% on the last day of the semester to 0.09% on the first day of July.

uncertainty. These are a ”time-series uncertainty”, defined as the standard deviation of the average daily repo spread on a 15-day rolling window, and a ”cross-section uncertainty”, given by the standard deviation of the difference between each contract spread and its daily average (15-day rolling window). In more rigorous terms, we construct the following measures:

$$\sigma_t^{TS} = \sum_{k=t-15}^{t-1} \sqrt{\left(\bar{s}_k - \bar{\bar{s}}_{t-1,t-15}\right)^2} \tag{12}$$

$$\sigma_t^{CS} = \frac{1}{15} \sum_{k=t-15}^{t-1} \sum_{l=1}^{n} \sqrt{\left(s_{l,k} - \bar{s}_k\right)^2} \tag{13}$$

where $\bar{s}_t$ is the average spread in day t and $\bar{\bar{s}}_{t-1,t-15}$ is an average of $\bar{s}_t$ in the days from $t-15$ to $t-1$.

The results for IV regressions with different instrumental variables are reported on Table 5. The three columns report the results for 2SLS regressions, where the lag of mar_t (the first column) has only been used, or this variable along with the two uncertainty measures together (the second and third column). The results are very stable, both across regressions with different instrumental variables and compared with the baseline regression. This confirms the magnitude of the impact of initial margins on the cost of funding, and allows us to exclude that the results of the baseline regression are biased because of endogeneity issues. This is confirmed by a simple endogeneity test, which confirms the null hypothesis of exogeneity with an F-test value of 0.001317 (and a p-value of 0.9712).

6.2.2 Fixed effects

We then turn to discuss the role of fixed effects. In Table 6, we compare the outcome of the baseline regression with the ones obtained by introducing fixed effects at the liquidity taker level or by not introducing fixed effects at all. The results displayed in the table confirm the robustness of our approach. Introducing fixed effects at the level of the liquidity taker, or not introducing fixed effects at all, does not change significantly the coefficients estimated in the baseline specification, where, it is recalled, fixed effects are at the level of liquidity providers. This confirms the intuition that: (i) idiosyncratic counterparty risk is not a concern in anonymous, centrally cleared trades; and that (ii) bank-specific bidding behaviour does not impact trading on the platform.

6.2.3 Data subsamples

The previous findings are broadly confirmed also in further regressions on data subsamples. In particular, if we estimate regression (11) separately for short-term (one-day maturity) and long-term contracts (over one-day maturity), we can see that the sign and magnitude of the estimated coefficients are quite stable (Table 7). Although the dimension of longer-term contracts is smaller than that of short-term contracts, and therefore estimates might be - to a certain extent - less robust, some interesting features emerge. First, the impact of liquidity risk on the cost of funding is higher for longer-term contracts, suggesting that an increase in the level of liquidity risk had a greater effect on the cost of funding on longer maturities. This may be because agents entering into contracts on longer maturities are less affected by immediate liquidity needs and thus take other factors - such as liquidity risk - more into account.

Potential idiosyncratic pressures occurring on specific dates have, -as expected-, a higher impact on short-term maturity contracts, since such pressures have to be tackled by market participants before the end of the trading day.

6.3 The impact of margins on quantities

We also run the baseline regression (11) considering quantity as our dependent variable instead of the cost of funding. This allows us to check whether margins - as predicted in the theoretical model - also impact quantities traded in each exchange on the market (see Table 8).[28] The effect of initial margins on the quantity exchanged in the single contract is negative, thus confirming the finding in the theoretical model. However, such coefficient is not significant both in the OLS and in the 2SLS regression where we use the lag of mar_t and the "cross-section" and "time-series" volatilities as instruments. On the other hand, credit risk seems to play a more important role in terms of quantities: a 100 bp increase in credit risk translates into a reduction of the quatities exchanged of about 1.5 EUR mln per contract.

[28] The only difference with the baseline regression - apart from the left-hand side variable, is the exclusion of the total volume of contracts exchanged during the day as a control variable.

Also liquidity seems to matter in terms of exchanged quantities. Also. the excess liquidity provided by the Eurosystem contributes increasing turnover in private markets. Compared with cost of funding regressions, the ones on quantities fit poorly.

6.4 Quantile regressions

The distribution in the cost of funding is characterised by a significant dispersion. Therefore, using our baseline framework as in Equation 11, we run quantile panel regressions on the 10th, 25th, 50th, 75th and 90th quantile. Also in this case, standard errors are robust and corrected for heteroskedasticity. In this way, we are able to estimate the potential differential effect of our covariates on the quantiles of the conditional distribution of our dependent variable, thus providing a richer data characterisation.

The regression coefficients, estimated over the whole sample period, are shown in Table 9. The results confirm that the impact of initial margins on the cost of funding remains significant and positive across the distribution. Interestingly, the magnitude of the effect decreases at the highest conditional quantiles of the distribution: a 100 basis-point increase in the initial margin translates into a significant and positive change in the cost of funding, in the range of 6 basis points up to the median and then decreasing significantly in the upper tail of the distribution. This finding suggests that other factors, such as credit and liquidity risks may play a bigger role for contracts in the right tail of the spread distribution. Indeed credit and liquidity risk are significantly and positively related to the cost of funding for all the quantiles and much more for the upper tail. Looking at the impact of the ECB interventions, it can be seen that the amount of excess liquidity in the system helps to ease the pressure on the cost of funding, with a larger estimated impact (in absolute terms) for higher quantiles. This effect is particularly pronounced for the 90th quantile - the coefficient being more than twice times larger than the one for the lowest quantile. The coefficients for the other explanatory variables are in line with our expectations, as well as in the estimation obtained in the baseline specification. Overall, these results point to the fact that in the upper tail of the distribution, -namely for those contracts whose rate far exceeds the Eurepo rate,- the cost of funding is less responsive to changes in initial margins but more responsive to other risk factors. We believe that the upper tail of the distribution is populated primarily by counterparties that are liquidity-constrained at that specific moment and are willing to conclude repos at higher rates to obtain funds. Our intuition is that, when aggregate liquidity is lower and risks are higher, liquidity-constrained counterparties pay higher funding costs to obtain secured credit.

6.5 A counterfactual exercise

The relevance of the above figures can be further assessed in the following counterfactual exercise, where we quantify the contribution of initial margins to the increase in repo spreads occurred during the financial turmoil. More precisely, we use the estimated coefficients from the richest regression in Table 4 and the regression on the median in Table 9, the residuals and the time series of the independent variables to calculate the spread that would have been realized if margins were kept at the pre-crisis level. In other words, we compute a counterfactual spread as:

$$\widehat{s}_{i,t} = \widehat{\alpha} + \widehat{\beta}_1 \overline{mar}_t + \widehat{\beta}_2 X^{mkt}_{t-1} + \widehat{\beta}_3 X^{repos}_t + \widehat{\varepsilon}_{i,t} \tag{14}$$

Where $\overline{mar}_t$ is the average pre-crisis level of weighted margin.[29] The results are reported in Table 10. The average spread observed in the data has been 20.8 basis points. If the margin had remained fixed at the pre-crisis level, the average spread in the sample would have been 18.2 basis points (using OLS estimates) or 17.8 basis points (using QR on the median). This translates into a reduction of about 10% compared with the average spread observed in the data. In other words, in a scenario of pre-crisis margins, the spread between the repo rates on the Italian MTS and the Eurepo rate would have been significantly lower than the value effectively observed on the markets. From this simple exercise, it could be argued that a non-negligible part of the funding cost can be explained by changes in margin policies.

[29] This value (3.3%) has been computed as an average over the period January - July 2011.

7 Conclusions

In this paper we investigated the impact of CCPs' initial margin policies on the cost of funding, showing the existence of a theoretical positive relationship between these two variables which is confirmed by empirical evidence. Drawing on an extensive transaction-level data set on the Italian MTS Repo market (the GC segment) available at the Bank of Italy for supervisory purposes for the period 2011-2012 we find that initial margins, paid by all participants, have significantly and positively affected on the cost of funding observed on GC MTS Repo Italy; on average, the impact is equal to about 3 basis points for each 1 percentage point variation in the margin. Among the other variables playing a role, we find that credit and liquidity risks, as well as variables capturing potential idiosyncratic pressures in liquidity needs (end-of-month, end-of-quarter and fiscal-due-date dummies), exert a significant and upward impact on the cost of funding. Variables linked to the level of excess liquidity in the euro area have instead a negative effect.

This paper thus represents a first attempt at identifying causal relationships in CCP-cleared repo markets in times of stress. Future research may be devoted to identifying whether different drivers of the cost of funding in non-centrally-cleared repo markets exist, and to empirically quantifying the relevance of self-fulfilling ("procyclical") dynamics.

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8 Tables

Table 1: Sample Description

Maturity	CCP Interoperability	CC&G	LCH	Total
ON	22,930	8,941	13,638	**45,509**
TN	24,631	10,427	15,189	**50,247**
SN	16,449	5,734	11,296	**33,479**
Total 1 day	***64,010***	***25,102***	***40,123***	***129,235***
1W	1,546	713	235	**2,494**
2W	481	1,906	47	**2,434**
1M	1,563	319	157	**2,039**
2M	173	32	1	**206**
3M	345	89	36	**470**
6M	38	17	3	**58**
9M	2	2	0	**4**
1Y	6	2	0	**8**
Total	**68,164**	**28,182**	**40,602**	**136,948**

Table 2: Descriptive statistics

Variable	**Mean**	**Std Dev**	**Min**	**Max**
Spread(b.p.)	20.66136	25.59141	-40.3	148.4
Margin (b.p.)	435.8454	155	291.0424	871.6059
Credit risk (b.p.)	544.6894	130.6256	416.6658	987.1637
Liquidity risk	4174.01	2685.997	310.0308	9073.77
Total Liquidity (bln euro)	143.4991	161.8312	-93.941	807.144
Total Volume (mln euro)	26.32327	7.978488	10.3635	49.718

Note: descriptive statistics are computed on a sample of 129,235 observations. ”Spread” is computed as the daily mean of the spread as computed in eq. (10). ”Margin” is the daily average level of margins weighted by the outstanding government debt amount for each bucket of duration. ”Credit risk” is the credit spread measure of (Gilchrist and Mojon, 2014) for the Italian banking sector. ”Liquidity risk” is the liquidity indicator of (Iachini and Nobili, 2014). ”Total liquidity” is excess liquidity for the euro area, computed as the sum of the deposit facility net of the recourse to the marginal lending facility, plus current account holdings in excess of those contributing to the minimum reserve requirements. ”Total volume” is the daily volume of GC repo transactions executed on the MTS Repo Italy trading platform.

Table 3: Correlation among credit and liquidity risk variables

	Liquidity	**Credit risk**	**BTP-Bund spread**	**VIX**	**BTP volatility**
Liquidity indicator	1				
Credit risk	0.8456*	1			
BTP-Bund spread	0.9387*	0.8739*	1		
VIX	0.6191*	0.5140*	0.5335*	1	
BTP volatility	0.7725*	0.6728*	0.7460*	0.4569*	1

Note: correlations computed on 129,235 observations. (*): significance level at 1%.

Table 4: Baseline Regressions

Dependent variable:	Eurepo Spread		RFR spread
Margin		**0.0302*** **	**0.0261*** **
		(0.00584)	*(0.00602)*
Credit Risk	**0.141*** **	**0.117*** **	**0.127*** **
	(0.00848)	*(0.0107)*	*(0.00779)*
Liquidity Risk	**0.00104*** **	**0.00144*** **	**0.00195*** **
	(0.000280)	*(0.000345)*	*(0.000290)*
Total Liquidity	**-0.0439*** **	**-0.0582*** **	**-0.0663*** **
	(0.00312)	*(0.00576)*	*(0.00544)*
Fiscal Due Dates	**5.181*** **	**5.252*** **	**5.776*** **
	(0.717)	*(0.726)*	*(0.710)*
Dummy Month	**8.623*** **	**8.446*** **	**8.331*** **
	(1.029)	*(1.000)*	*(0.647)*
Dummy Quarter	**20.47*** **	**22.02*** **	**48.46*** **
	(3.788)	*(3.575)*	*(6.459)*
Total Volume	**-0.297*** **	**-0.270*** **	**-0.244*** **
	(0.0397)	*(0.0382)*	*(0.0306)*
Dummy provider	**6.443*** **	**6.249*** **	**7.506*** **
	(0.722)	*(0.669)*	*(0.918)*
Maintenance Period	**3.180*** **	**3.739*** **	**16.86*** **
	(0.997)	*(0.950)*	*(2.066)*
Constant	**-51.38*** **	**-51.30*** **	**-50.07*** **
	(2.942)	*(2.788)*	*(2.857)*
Observations	128901	128901	128901
R-squared	***0.592***	***0.599***	***0.580***

Note: "Fiscal Due Dates" is a dummy that takes value one on Italian fiscal due dates and zero otherwise. "Dummy Month", "Dummy Quarter" and "maintenance period" take value one in the last day of the month, of the quarter and of the maintenance period, respectively, and zero otherwise. "Dummy provider" takes value one if the liquidity provider initiates the contract and zero otherwise. Standard errors are reported in parenthesis and are clustered at the liquidity provider level. The RFR spread is computed as the difference between the contract rate and a volume-weighted average of RepoFunds rates for Germany and France.

Table 5: Robustness checks with instrumental variables

	(IV= Lag margin)	(IV= Lag Margin and cross-section vola.)	(IV= Lagged Margin, cross-section and time series vola.)
Margin	**0.0591*** **	**0.0482*** **	**0.0258*** **
	(0.00694)	*(0.00678)*	*(0.00543)*
Credit Risk	**0.0942*** **	**0.104*** **	**0.123*** **
	(0.0114)	*(0.0115)*	*(0.00990)*
Liquidity Risk	**0.00185*** **	**0.00171*** **	**0.00142*** **
	(0.000370)	*(0.000370)*	*(0.000339)*
Total Liquidity	**-0.0748*** **	**-0.0704*** **	**-0.0613*** **
	(0.00695)	*(0.00675)*	*(0.00556)*
Fiscal Due Dates	**5.506*** **	**5.442*** **	**5.311*** **
	(0.774)	*(0.768)*	*(0.746)*
Dummy Month	**7.910*** **	**7.900*** **	**7.879*** **
	(1.113)	*(1.126)*	*(1.155)*
Dummy Quarter	**23.95*** **	**23.47*** **	**22.50*** **
	(3.510)	*(3.529)*	*(3.637)*
Total Volume	**-0.249*** **	**-0.260*** **	**-0.283*** **
	(0.0354)	*(0.0355)*	*(0.0339)*
Dummy provider	**6.180*** **	**6.236*** **	**6.353*** **
	(0.681)	*(0.687)*	*(0.699)*
Maintenance Period	**4.404*** **	**4.232*** **	**3.881*** **
	(0.916)	*(0.934)*	*(0.961)*
Constant	**-51.74*** **	**-51.93*** **	**-52.32*** **
	(2.619)	*(2.681)*	*(2.803)*
Observations	124415	124415	124415
R-squared	***0.594***	***0.598***	***0.601***

Note: Standard errors are reported in parenthesis and are clustered at the liquidity provider level.

Table 6: Robustness checks with different fixed effects specifications

	No fixed effects	FE on liquidity provider	FE on liquidity taker
Margin	**0.0272*** **	**0.0258*** **	**0.0260*** **
	(0.00587)	*(0.00554)*	*(0.00526)*
Credit Risk	**0.122*** **	**0.118*** **	**0.118*** **
	(0.0101)	*(0.0104)*	*(0.00713)*
Liquidity Risk	**0.00144*** **	**0.00140*** **	**0.00136*** **
	(0.000351)	*(0.000319)*	*(0.000201)*
Total Liquidity	**-0.0619*** **	**-0.0586*** **	**-0.0588*** **
	(0.00604)	*(0.00586)*	*(0.00318)*
Fiscal Due Dates	**5.319*** **	**5.081*** **	**5.090*** **
	(0.752)	*(0.678)*	*(0.451)*
Dummy Month	**7.881*** **	**7.828*** **	**7.449*** **
	(1.161)	*(1.118)*	*(1.368)*
Dummy Quarter	**22.56*** **	**22.62*** **	**23.76*** **
	(3.632)	*(3.690)*	*(3.830)*
Total Volume	**-0.282*** **	**-0.301*** **	**-0.256*** **
	(0.0350)	*(0.0379)*	*(0.0273)*
Dummy provider	**-6.346*** **	**-6.176*** **	**-5.706*** **
	(0.700)	*(0.681)*	*(0.998)*
Maintenance Period	**3.904*** **	**3.987*** **	**4.082*** **
	(0.989)	*(0.931)*	*(0.671)*
Constant	**-45.95*** **	**-43.22*** **	**-44.63*** **
	(2.728)	*(3.431)*	*(3.256)*
Observations	124415	124415	124415
R-squared	***0.601***	***0.616***	***0.621***

Note: Standard errors are reported in parenthesis and are clustered at the liquidity provider level in the first two columns, while they are clustered at the liquidity taker level in the third column.

Table 7: 1 day contracts vs longer maturities contracts

	1 day	>1day
Margin	**0.0272*** **	**0.0380*** **
	(0.00587)	*(0.00287)*
Credit Risk	**0.122*** **	**0.103*** **
	(0.0101)	*(0.00975)*
Liquidity Risk	**0.00144*** **	**0.00203*** **
	(0.000351)	*(0.000348)*
Total Liquidity	**-0.0619*** **	**-0.0307*** **
	(0.00604)	*(0.00216)*
Fiscal Due Dates	**5.319*** **	**1.773** **
	(0.752)	*(0.846)*
Dummy Month	**7.881*** **	**3.454** **
	(1.161)	*(1.537)*
Dummy Quarter	**22.56*** **	**11.25*** **
	(3.632)	*(2.672)*
Total Volume	**-0.282*** **	0.00737
	(0.0350)	*(0.0360)*
Dummy provider	**6.346*** **	0.624
	(0.700)	*(1.752)*
Maintenance Period	**3.904*** **	**-1.907* **
	(0.989)	*(1.084)*
Maturity		**0.0650*** **
		(0.00810)
Constant	**-52.29*** **	**-50.38*** **
	(2.804)	*(4.825)*
Observations	124415	20689
R-squared	***0.601***	***0.647***

Note: Standard errors are reported in parenthesis and are clustered at the liquidity provider level. "Maturity" is the maturity of the contract in number of days.

Table 8: Regression on contract volumes

	OLS	2SLS
Margin	-0.00322	-0.00317
	(0.00348)	(0.00578)
Credit Risk	**-0.0154****	**-0.0155****
	(0.00625)	(0.00781)
Liquidity Risk	**-0.00108*****	**-0.00108*****
	(0.000325)	(0.000342)
Total Liquidity	**0.00643***	0.00641
	(0.00375)	(0.00485)
Fiscal Due Dates	0.217	0.217
	(0.952)	(0.946)
Dummy Month	-2.571	-2.571
	(2.188)	(2.172)
Dummy Quarter	1.333	1.336
	(2.521)	(2.512)
Dummy provider	**2.422****	**2.421****
	(1.072)	(1.056)
Maintenance Period	-2.098	-2.097
	(1.690)	(1.659)
Constant	**55.33*****	**55.33*****
	(2.674)	(2.716)
Observations	124415	
R-squared	***0.008***	***0.008***

Note: Standard errors are reported in parenthesis and are clustered at the liquidity provider level. Instruments in the 2SLS regression are the lagged margin and cross-section and time series volatilities, as defined in the text.

Table 9: Quantile regressions

Quantile	10th	25th	50th	75th	90th
Margin	**0.0665*** **	**0.0519*** **	**0.0275*** **	**0.0203*** **	0.00846
	(0.00386)	*(0.0102)*	*(0.00964)*	*(0.00731)*	*(0.00853)*
Credit Risk	**0.0341*** **	**0.0662*** **	**0.121*** **	**0.164*** **	**0.211*** **
	(0.00872)	*(0.0165)*	*(0.0132)*	*(0.0198)*	*(0.0177)*
Liquidity Risk	**0.000725** **	**0.000540** **	**0.000710*** **	**0.00126** **	**0.00144* **
	(0.000296)	*(0.000213)*	*(0.000273)*	*(0.000552)*	*(0.000819)*
Total Liquidity	**-0.0352*** **	**-0.0421*** **	**-0.0462*** **	**-0.0617*** **	**-0.0758*** **
	(0.00149)	*(0.00532)*	*(0.00715)*	*(0.00688)*	*(0.00908)*
Fiscal Due Dates	**3.140*** **	**3.189*** **	**3.947*** **	**3.534*** **	**4.011*** **
	(0.740)	*(0.369)*	*(0.443)*	*(0.813)*	*(1.205)*
Dummy Month	**8.551*** **	**6.670*** **	**8.577*** **	**8.184*** **	**9.928*** **
	(0.548)	*(0.559)*	*(0.627)*	*(0.967)*	*(2.644)*
Dummy Quarter	2.060	**13.90*** **	**20.21*** **	**34.90*** **	**39.65*** **
	(4.411)	*(1.130)*	*(1.905)*	*(12.74)*	*(4.917)*
Total Volume	0.0496	**-0.103*** **	**-0.240*** **	**-0.383*** **	**-0.582*** **
	(0.0448)	*(0.0387)*	*(0.0230)*	*(0.0373)*	*(0.0781)*
Dummy provider	**3.853*** **	**3.862*** **	**3.882*** **	**4.530*** **	**5.558*** **
	(0.922)	*(0.501)*	*(0.379)*	*(0.575)*	*(1.008)*
Maintenance Period	1.570	**4.496*** **	**3.953*** **	**4.533*** **	**4.429* **
	(1.514)	*(0.946)*	*(0.940)*	*(1.231)*	*(2.465)*
Constant	**-45.67*** **	**-44.39*** **	**-51.89*** **	**-59.63*** **	**-63.31*** **
	(2.580)	*(3.980)*	*(3.193)*	*(5.771)*	*(6.310)*
Observations	128901	128901	128901	128901	128901
Obs	*128901*				
R-squared	***0.522***	***0.577***	***0.594***	***0.592***	***0.589***

Note: Standard errors are reported in parenthesis and are clustered at the liquidity provider level.

Table 10: Conterfactual exercise

Mean Spread (data)	20.8	
	Quantile	**OLS**
Counterfactual	17.8 *(-11.4%)*	18.2 *(-9.5%)*