

Discussion Paper

Deutsche Bundesbank
No 14/2016

How central is central counterparty clearing? A deep dive into a European repo market during the crisis

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Internet <http://www.bundesbank.de>

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ISBN 978-3-95729-253-7 (Printversion)

ISBN 978-3-95729-254-4 (Internetversion)

Non-technical summary

Research Question

With the crisis, borrowing conditions on unsecured and many secured money markets deteriorated. By contrast, certain repo markets offering anonymous trading and central counterparty (CCP) clearing have grown and proved remarkably stable. To better understand the mechanics of these successful markets and how they relate to financial stability, we describe the setup and microstructure of the Eurex Repo General Collateral Pooling (GCP) market, a major funding-driven repo market in Europe. Further, we look at the interaction between non-standard monetary policy measures and GCP to see whether central bank liquidity complements or crowds out private funding markets.

Contribution

Using information on each transaction between 2006 and mid-2012 allows us to trace market participants over time and to study repo activity in detail. This represents a major novelty given the scarcity of data on repos. We contribute to the literature by documenting the evolution of repo rates and volumes during the financial turmoil as well as under changing monetary policy and by analyzing the underpinning microstructure of the market. We also compare our results to the main CCP cleared repo funding market in the US, the General Collateral Financing market.

Results

We find high liquidity provision by the central bank being associated with lower private liquidity provision in the GCP market. With long-term central bank liquidity, we also observe an increase in bilaterally agreed transactions, in which contracting partners know each other and maturities are, on average, longer. Looking at additional aspects, we find the Lehman bankruptcy not to have been a watershed for the GCP market, having had no systematic impact on the repo rates and the transaction volume of banks. Apart from anonymity, market participants benefit from the netting of liquidity borrowed and lent, whereby collateral needs are strongly reduced.

Nichttechnische Zusammenfassung

Fragestellung

In der Krise haben sich die Kreditkonditionen auf unbesicherten und manchen besicherten Geldmärkten verschlechtert. Im Gegensatz dazu haben Repomärkte, an denen anonym gehandelt und über zentrale Gegenparteien (CCP) abgewickelt wird, an Bedeutung gewonnen. Um deren Rolle, auch in Bezug zur Finanzstabilität, besser zu verstehen, beschreiben wir die Ausgestaltung und Struktur des Eurex Repo GC Pooling (GCP) Marktes, eines der wichtigsten besicherten Geldmärkte in Europa. Wir untersuchen zudem die Interaktion von unkonventioneller Geldpolitik und GCP, um zu sehen, ob die Zentralbankliquidität den privaten Markt ergänzt oder verdrängt.

Beitrag

Anhand von Informationen über jede GCP Transaktion im Zeitraum 2006 bis Mitte 2012 beobachten wir die Marktteilnehmer über die Zeit und untersuchen deren Handelsaktivitäten. Dies stellt eine wesentliche Neuerung dar, da umfangreiche Daten zu Repogeschäften bislang kaum verfügbar sind. Wir beschreiben die Entwicklung von Preisen und Handelsvolumen während der Krise und unter wechselnden geldpolitischen Rahmenbedingungen und analysieren die Marktmikrostruktur im Detail. Des Weiteren vergleichen wir die Resultate unserer Analyse mit Studien zum größten CCP basierten Repomarkt in den USA, dem *General Collateral Financing market*.

Ergebnisse

Wir finden, dass hohe Liquiditätsbereitstellung seitens der Zentralbank mit geringerer Liquiditätsbereitstellung in dem GCP Markt einhergeht. Mit der Bereitstellung langfristiger Zentralbankliquidität werden längerfristige, bilateral vereinbarte Transaktionen wichtiger. Wir beobachten zudem, dass die Insolvenz von Lehman Brothers keine systematischen Auswirkungen auf den Repozins und das Handelsvolumen der Banken hatte. Neben der Anonymität profitieren die Banken von der Möglichkeit, erhaltene und verliehene Liquidität in GCP zu verrechnen, wodurch sich der Bedarf an Bereitstellung von Sicherheiten deutlich reduziert.

How central is central counterparty clearing? A deep dive into a European repo market during the crisis¹

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Abstract

Repo markets offering central counterparty (CCP) clearing and anonymized trading were remarkably resilient during the recent crises. We use the full transaction level dataset on all repo trades on Eurex Repo, including identifiers for market participants, to provide a detailed description of the market's development and microstructure during the crises and under different monetary policy interventions. Overall, we find high excess liquidity being associated with lower private liquidity provision in this market. Cross-segment arbitrage and market making is limited but growing steadily. The reallocation of liquidity risk across banks within this market varies substantially with the general market conditions.

Keywords: repo, central counterparty, market microstructure, financial crisis

JEL-Classification: G2, D4, E58

¹ Contact address: Wilhelm-Epstein Str. 14, 60431 Frankfurt am Main, Germany. Phone: +49 69 9566 4729. E-Mail: andre.ebner@bundesbank.de. We would like to thank Eurex Repo GmbH for kindly making available the data used in this analysis and for answering our questions regarding the dataset. This analysis has profited from discussions with colleagues at the Bundesbank as well as from comments received at the Bundesbank research seminar and from Judith Kilp. All errors remain our own. Discussion Papers represent the authors' personal opinions and do not necessarily reflect the views of the Deutsche Bundesbank or its staff.

1. Introduction

Prior to the crisis, repos, which are essentially secured loans with the collateral changing ownership,² became a key source of financing. Even after a crisis-related reduction, outstanding repos amounted to \$3 trillion in the US at the beginning of 2012 (Copeland et al. 2012) and €2.8 trillion in the EU at the end of 2011 (ICMA 2012)³ compared to a US GDP of roughly \$15.5 trillion and EU-28 GDP of €13 trillion in 2012 (at 2010 prices). While representing secured funding and having long been regarded as safe by regulators, repos are not without risk.

Repos contributed to rising leverage in the banking sector as borrowed money was invested in securities used as collateral in repos. They were part of the business model of the shadow banking system that used self-generated securities as collateral in repos that helped to finance further the purchase and securitization of loans.⁴ When vulnerabilities were realized and repo lending dried up, the financial system was at the brink of collapse.⁵ In the US, the average haircut on securities used in bilateral repos, not including US treasury securities, increased from roughly 0% to around 45% between 2007 and end-2008 (Gorton and Metrick 2012). There were also severe strains in the tri-party market, prompting the Federal Reserve to provide support via the Primary Dealer Credit Facility (PDCF).⁶ By contrast, some repo segments, in particular tri-party repos drawing on a pooled basket of collaterals, grew in the crisis, offering important funding opportunities when liquidity was scarce. Among those are the General Collateral Pooling (GCP) repos traded on Eurex Repo, with around €140 billion in outstanding repo volume at end-2011.

For financial stability, it is key to understand the microstructure of these markets and their resilience in the crisis as well as their interaction with non-standard monetary policy measures. In particular, it is of interest whether public liquidity provision complements or

² See the appendix for a short primer on repos. For an overview of the evolution of repos see Garbade (2006).

³ Absent comprehensive data, estimates differ. Copeland et al. (2012) provide single counted data (not summing repos and reverse repos), while ICMA reports a market size of €5.6 trillion referring to both lending plus borrowing positions. Based on 2008 figures, Gorton and Metrick (2012) estimate outstanding repo volume in the US to \$10 trillion (double-counted), roughly the size of the total assets in the US banking system at the beginning of 2010.

⁴ More recent research finds that securitized assets were predominantly funded via asset backed commercial paper (ABCP) or direct investments by money market investors and less so by repos, and that it was more interdealer repo markets that were affected by knock-on effects once money markets contracted (Krishnamurthy et al. 2014).

⁵ In this regard, also the regulatory treatment of repos played a role. Sheila Bair, chair of the Systemic Risk Council and 2006-2011 Chair of the FDIC, made this point on June 9, 2013 by saying: "repos among financial institutions are treated as extremely low risk, even though excessive reliance on repo funding almost brought our system down. How dumb is that?". For the effect of the financial crisis on the unsecured US overnight interbank market, see Gara et al. (2011).

⁶ See http://www.federalreserve.gov/newsevents/reform_pdcf.htm. Copeland et al. (2010, 2014) discuss the US tri-party market. See Hördahl and King (2008) for repo market developments across countries.

crowds out private funding markets such as GCP, which matters for the effectiveness of enhanced central bank liquidity injections.

In this paper we use a unique dataset that comprises each repo transaction on Eurex Repo from 2006 to mid-2012 and an identifier for each market participant. Amongst other things, we know which collateral basket was used in the repo and whether the transaction was buyer- or seller-initiated. These data allow us to provide a comprehensive description of the market microstructure in this market. We study how concentration, market liquidity and intermediation in this market evolved over time. We also look at different aspects of repo trading, including cross-basket activity and the relevance of bilaterally agreed transactions.

In a nutshell, we find the following: GCP has grown strongly since 2006, in terms of both market participants and trading volume. However, longer-term refinancing operations (LTRO) are associated with lower GCP volume and an increase in bilaterally agreed transactions. This may point to a possible substitution or segmentation effect that could reduce the effectiveness of central bank liquidity provision. Further, the market is rather concentrated, with individual banks mainly borrowing or lending liquidity on a given day. Only rarely do banks serve as intermediaries or market makers in either of the market segments on a given day. Market liquidity is higher in the segment for high quality collateral, and LTROs compress bid-ask spreads. Trading between collateral baskets possibly occurs to take advantage of rate differentials or to upgrade collateral, which might become more important with the phasing-in of new regulatory liquidity requirements. In the appendix we provide evidence on three further selected topics: the Lehman bankruptcy was not a watershed with regard to trading volume and repo rates of single banks in GCP; however, over the sample period there are instances when banks are willing to pay a higher repo rate than the rate charged for tapping the central bank's marginal lending facility. Besides anonymity, settlement netting is a major advantage for market participants. Net cash flows amount to less than 40% of gross flows towards the end of our sample period, with resulting efficiency gains and lower collateral needs. Window dressing on reporting days might also drive banks' trading patterns.

Analyzing the structure of repo markets and its implications for financial stability comes timely also in light of the current regulatory debate on preserving stable funding liquidity. We contribute to the literature by documenting in detail the evolvement of Eurex Repo rates and volumes during the financial turmoil as well as under changing monetary policy and by analyzing the underpinning microstructure of the market. This represents a major novelty, given the general scarcity of aggregate and, especially, micro data on repos. Closely related are the study by Agueci et al. (2014) on the General Collateral Financing repo market (GCF Repo[®]), which describes the microstructure of the main CCP market in the US, and the study

by Copeland et al. (2010) on the US tri-party repo market.⁷ Data on Eurex GCP are also employed by Mancini et al. (2015) for an aggregate analysis of the main drivers of the repo spread, trading volume and the average repo term.⁸

The remainder of this paper is structured as follows. Section 2 gives an overview of repos and different market segments with an emphasis on CCP cleared repos in Europe and the Eurex GCP market. Section 3 introduces the data which are used in Section 4 to describe the (micro)structure of the market. Sections 5 and 6 explain the behavior around bilateral repos and cross-basket trading. The main findings are summarized in the concluding section.

2. An introduction to the GCP market

GCP offers anonymous and centrally cleared trading, a market design that has benefitted from banks' increasing risk aversion since the crisis but also from a new focus on the efficient use of collateral and on prudential requirements. CCP clearing with multilateral netting replaces bilateral credit risk with credit risk on the CCP. Whereas in bilateral markets participants have a legal relationship and exposure to each other in a web of interdependencies, CCPs may be better at monitoring risks due to more comprehensive information and thus at setting adequate initial margins.⁹ Furthermore, the responsibility to liquidate collateral, should a counterparty default, lies with the CCP, which may be more adept in this task than market participants. In addition, such repo transactions offer low prudential requirements and can be combined with anonymous trading, as in the case of GCP.

However, while CCPs can insulate a market against crisis, this does not always have to be the case. On the one hand, the CCP itself can default or nearly fail if risk management is not conservative enough and market participants failed to adequately monitor counterparty credit risk in the false belief that it had been eliminated.¹⁰ Since counterparty risk is concentrated at the CCP, this could lead to systemic risk. On the other hand, the CCP may remain viable, but market participants attach a high probability of default to it if confidence in the quality of the eligible collateral erodes, raising risk premia on repos. This could have been the case for GC repo markets using sovereign bonds from GIPS countries as collateral during the European

⁷ Agueci et al. (2014) provide an overview of the GCF repo service depending upon the tri-party repo platform and analyze the period March 2011 to September 2012. Copeland et al. (2010) cover 2008 to 2010.

⁸ The repo spread is defined as GCP repo rate over ECB refinancing rate. A further noteworthy study is Dunne et al. (2011), who analyze repos (predominantly specials) traded on the BrokerTec electronic order book and relate repo liquidity conditions to bidding behavior at ECB auctions. See also Dunne et al. (2014).

⁹ In the case of GCP, an important role might also have been played by the exclusion of some securities from the eligible collateral pool as the crisis evolved, which equals a haircut of 100%. There are, however, limitations to a pre-post crisis evaluation of the GCP segment, as the market was still very small at the onset of the financial turmoil.

¹⁰ See, for instance, Caisse de Liquidation (1974), Kuala Lumpur Commodity Clearing House (1983) and Hong Kong Futures Guarantee Corporation (1987). Hills et al. 1999 provide a short description of these cases.

sovereign debt crisis (Boissel et al. 2014).¹¹ CCPs might also give rise to macro-prudential risks even if the micro-prudential risk management is sound. This could stem from procyclical risk management such as stricter margin and haircut requirements in times of financial stress, the default of systemically important clearing members, or interdependencies between CCPs, their members as well as other financial market infrastructures (Hermans et al. 2013, Armakola and Laurent 2015). (Some of) these risks are addressed by the international CPSS-IOSCO principles for financial market infrastructure and the European Market Infrastructure Regulation (EMIR). Requirements for organizational, business conduct and prudential frameworks should strengthen the resilience of CCPs and take macro-prudential concerns into account to some extent, while work on recovery and resolution regimes for CCPs is ongoing.¹²

Eurex Repo is, alongside ICAP BrokerTec and MTS, one of the three main electronic repo platforms offering CCP cleared transactions. GCP, operated by Eurex, is a cash-driven market offering general collateral (GC) repos.¹³ The cash provider only knows that the collateral meets credit and liquidity criteria based on a defined collateral basket, but does not know ex-ante the specific collateral it receives. GCP allows funding in euro and US dollar collateralized by harmonized baskets. Trading follows a given procedure (see Figure 1, panel A). First, a market participant anonymously quotes a repo or reverse repo transaction in a collateral basket on the electronic platform of Eurex Repo (so-called non-aggressor) or anonymously accepts such a quote in the system (so-called aggressor).¹⁴ Participants purchasing collateral in the front leg of the transaction are buyers or cash providers, while those selling collateral are sellers or cash takers. Once the details of a transaction have been agreed during the matching process, Eurex Clearing¹⁵ acting as CCP immediately becomes the legal counterparty to the aggressor and non-aggressor. Next, Eurex Repo forwards the transaction details to Eurex Clearing, which confirms receipt and sends clearing reports to the trading partners. Eurex Repo then confirms the transaction. On the settlement day of the front leg, Eurex Clearing sends on behalf of the customers the netted settlement instructions to

¹¹ By contrast, the collateral framework of Eurex's GCP market is restricted to the ECB eligible collateral universe and excludes issues from countries with severe sovereign debt problems.

¹² The European Commission will review requirements set by EMIR by 17 August 2015. Part of the review will be an assessment – in cooperation with the European Securities and Markets Authority and the European Systemic Risk Board – of the efficiency of margin requirements to limit procyclicality. In October 2014 the FSB reissued the Key Attributes of Effective Resolution Regimes for Financial Institutions including financial market infrastructures such as CCPs. The European Commission conducted a consultation on a possible framework for the recovery and resolution of nonbank financial institutions in late 2012.

¹³ 55% of euro-denominated repos are CCP cleared with the trend increasing (ECB 2012, 2010). GC repo accounts for 22.3% of electronic repo trading (ICMA 2012). For more information and a brief introduction to repos, see the appendix.

¹⁴ Note that for cash providers, fees per trade are higher when accepting quotes than when posting quotes, while there is no such difference for liquidity takers (Eurex Repo 2013). There are no official market makers in the GCP market.

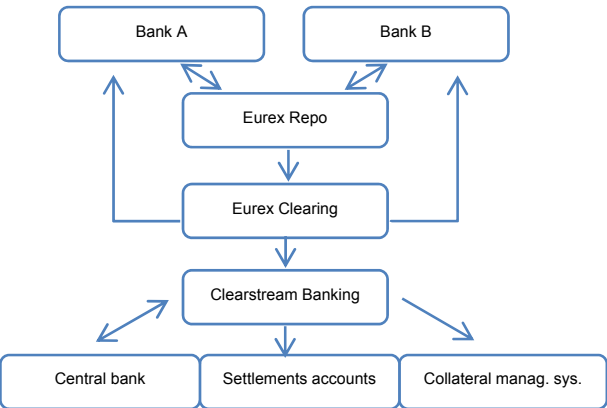
¹⁵ Eurex Clearing is licensed as a credit institution under the supervision of the Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) and is also an authorized clearing house under the European Market Infrastructure Regulation (EMIR). It complies with the CPSS/IOSCO principles for CCPs.

Clearstream Banking for settlement, except for overnight transactions, which are settled gross in real time in the front leg.¹⁶ In the delivery versus payment process, the collateral management system of Clearstream Banking automatically allocates eligible collateral out of the cash taker’s securities pool to collateralize the traded cash amount.¹⁷ The system transfers specific securities according to an internal algorithm, unless the cash taker flags certain securities for priority use in the securities’ account. The securities are then encumbered during the term of the trade, but real-time substitution of collateral is allowed. The cash leg is settled in commercial bank or central bank money.

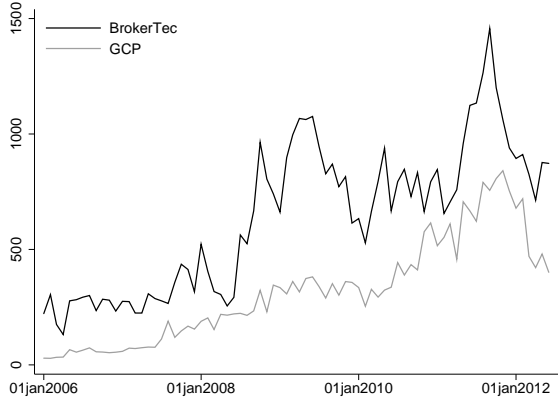
GCP allows the reuse of collateral from the ECB basket for refinancing within the framework of Eurosystem open market operations, although during our sample period this was initially only for participants based in Germany and later also in Luxembourg via the Bundesbank or Banque Centrale du Luxembourg.¹⁸ Further, collateral can be reused within the framework of the market concerned, as well as for fulfilling overall Eurex Clearing margin obligations (for all GCP baskets). In contrast to the US tri-party and the GCF market, during the term of the trade there is no unwinding of positions or extension of intraday credit involved.

Figure 1: GCP market

Panel A: GCP market concept



Panel B: CCP cleared GC repo volume



Note: Monthly figures in € billion (panel B). Sources: Eurex Repo¹⁹ and Icap BrokerTec.

The two main GCP baskets, the ECB basket and the ECB EXTended basket, have always used a narrower collateral framework than the ECB for its open market operations. The Euro

¹⁶ Only overnight transactions that could not be settled in real time are processed during the night-time processing cycle and considered for settlement day netting. Netting is applied to a bank’s cash flows in the same basket and currency and also involves cash flows from overnight transactions at their term leg.

¹⁷ Clearstream operates as an international securities depository (ICSD) in Luxembourg and as a central securities depository (CSD) in Frankfurt. Customers have an account at the respective collateral management systems (CmaX/Xemac), which are linked to each other. Customers may combine their assets in both systems to create a consolidated securities pool. In their securities pool, market participants can flag securities that are to be used in transactions.

¹⁸ As of 29 September 2014, customers of tri-party collateral management services offered by tri-party agents (TPAs), also on a cross-border basis, have the right to pledge securities for central bank operations, subject to the TPAs having been approved as eligible for use in Eurosystem operations (<https://www.ecb.europa.eu/mopo/assets/coll/ccbm/html/index.en.html>).

¹⁹ For Panel A, see <http://www.clearstream.com/blob/10230/b35eb60b4be016c18f5660da0e3f38d5/migrated-85819r461nsgden-euro-gc-pooling-product-pdf-data.pdf>

GCP ECB basket was introduced in March 2005 and currently comprises approximately 4,000 ECB eligible securities issued by central banks, central/regional/local governments, supranationals, and credit institutions or agency credit institutions (Pfandbriefe). Assets pledged as collateral have to be rated A-/A3 or higher and, given that the baskets were designed to be reusable with the Eurosystem, must fulfill all technical requirements for central bank eligibility.²⁰ Issuers whose residence is in Greece, Ireland, Portugal, Spain or (since January 27, 2012) Italy are ineligible (as of October 2012). The majority of assets becoming ineligible over time did so because they no longer fulfilled rating requirements. However, the CCP also applied restrictions through changes in the eligibility criteria in 2012 in order to hedge risks. Recently, the basket became narrower as it was adapted to the criteria for Level 1 assets under the Liquidity Coverage Ratio as of 28 April 2015, with covered bonds having to fulfill the requirements for high quality liquid assets and being assigned a minimum rating of AA-. Further, the basket has become narrower as it has been adapted to the criteria for Level 1 assets under the Liquidity Coverage Ratio as of 28 April 2015, with – amongst others – covered bonds having to fulfill the requirements for high quality liquid assets and being assigned a minimum rating of AA-. The ECB basket is traded in euro or US dollar, and also against the Swiss franc since 2014.

In addition, Eurex Repo introduced the ECB EXTended basket on 24 November 2008 that is tradeable in euro (also in US dollar and Swiss franc since 2014) but cannot be reused for central bank operations. This basket was mainly intended to allow raising funds by pledging a broader set of assets in GCP, with the effect being increased by the (temporary) extensions of the Eurosystem's collateral framework. Building on the ECB basket, around 25,000 ECB eligible securities are accepted (minimum rating requirement defined by the ECB) issued by a broad set of issuers including agency non-credit institutions, corporate and other issuers. Excluded are certain instruments such as (Treasury) Bills, Commercial Papers and Certificates of Deposit issued by corporate issuers and non-agency credit institutions and not guaranteed by a central government as well as all assets defined as ABS/MBS and other securitized bonds (Eurex Repo 2013). Issuers whose residence is in Greece or Portugal are ineligible, while restrictions apply to the issuer group for Spain, Italy and Ireland (as of October 2012).²¹

²⁰ As an additional technical requirement for reuse with the Eurosystem, an assessed link between Clearstream and the local CSDs has to be in place (<http://www.clearstream.com/clearstream-en/products-and-services/global-securities-financing/global-liquidity-hub-csd-services/triparty-collateral-services--xemac-/pledge-to-central-banks>).

²¹ Bonds with issuer residence in Greece have never been eligible, while bonds with issuer residence in Portugal became ineligible on January 27, 2012. Issuers from Spain (since July 4, 2012) and Italy as well as Ireland (since July 30, 2012) belonging to any of the groups' credit institutions (excluding agencies), regional/local government, and financial corporations other than credit institutions are ineligible. For other issuer groups the ECB eligibility criteria remain in force.

For the GCP baskets there are no restrictions on maturity, reaching from overnight to more than two years. Market participants signed up to GCP have the right to trade in all baskets, but some participants may be subject to internal restrictions to trade in only some of them.

Comparing the market size of Eurex GCP market with that of its main competitor in Europe, ICAP BrokerTec, reveals an average monthly trading volume of €636 billion (GCP) versus €981 billion (BrokerTec) between March 2011 and June 2012 (Figure 1, panel B).²² The US GCF market is considerably larger by comparison (with an average monthly trading volume of \$9,860 billion or €7,620 billion).²³

3. Data

We draw on data on Eurex's GCP segment, comprising the details of every repo or reverse repo transaction over January 2, 2006 to June 27, 2012. Due to the small number of trades, we exclude transactions in US dollar or trades based on the Equity basket.²⁴ Data offer an anonymized, but over time traceable, identifier for each market participant as well as information on who borrows (seller of security) and lends (buyer), and who initiated the loan. Further, we know the loan amount, repo rate, the date on which the transaction was concluded, the date on which the security was purchased (front leg) and then repurchased (second leg), and the basket to which the security pledged as collateral belongs (ECB, ECB EXTended).

With data being anonymized, it is not possible to match the dataset with other information at the bank level. The published list of market participants shows that registered market participants are either credit institutions or investment firms as well as the German and Dutch state treasury agency, the European Investment Bank, the European Financial Stability Facility, and the Banque Central du Luxembourg (as of October 1, 2012). Two months after our sample ends, 99 market participants were registered, of which 10 were from non-euro EU countries (8 from the UK, 1 from both Denmark and Switzerland), 47 from Germany, 32 from Austria, and the remaining participants from other euro-area countries. Participants are mostly internationally active banks domiciled in these countries or affiliates registered in European countries.

Figure 2 shows the cumulative number of market participants (referred to as banks in the following) as they appear in the data. It grew steadily but slowly until mid-2010, when it started to take off, finally reaching 94 (panel A). Most banks traded at least once in each basket, although the participation rate in the ECB EXTended basket (in the following

²² Volumes are single-counted. GCP figure includes the Equity basket but excludes repos in US dollar.

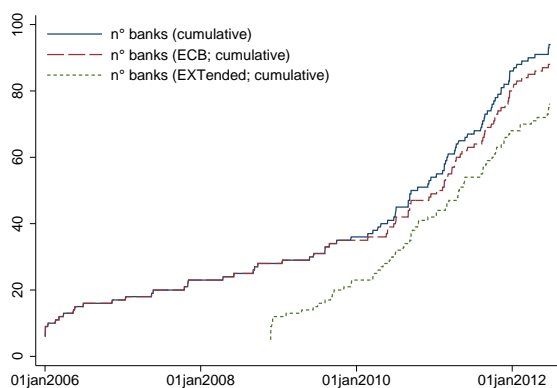
²³ For GCF, the average daily trading volume stood at \$493 billion between March 2011 and September 2012, when single-counted (Aguerci et al. 2014). This amounts to \$9,860 billion per month based on 20 trading days or €7,620 billion (using a December 2011 exchange rate of 1.2939). The overall trading volumes in cash-driven repos are likely related to different monetary policy frameworks in the US and the euro area.

²⁴ The option to trade in US dollar was only introduced on January 29, 2010.

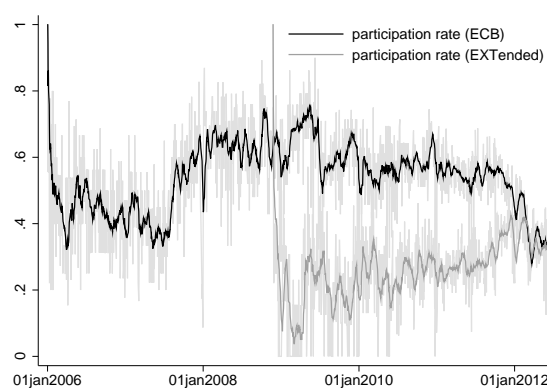
EXTended for short) is lower. Similarly, the weekly number of distinct trading banks increased to more than 60 in the entire sample up to the end of 2011. By contrast, trading banks as a share of registered banks shows no clear trend in the ECB basket (70% between 2008 and 2010 and 50% to 60% thereafter; panel B), while it increased in the EXTended basket. At the end of the sample period, the participation rate and the number of distinct trading banks in a week dropped in the ECB basket and somewhat less in the EXTended basket.²⁵ Both the increase in the number of banks and the change in participation rate were reflected in the traded volume.

Figure 2: Number of distinct banks in GCP

Panel A: First appearance (cumulative)



Panel B: Participation rate



Note: First appearance denotes the first day a new market participant is trading in our sample, which can differ from the day of registration. The participation rate is defined as distinct market participants trading on a given day relative to the number of market participants that have already traded in the corresponding segment in the past. Panel B shows 20-day moving averages with actual daily participation rates depicted in light grey.

4. Aggregate developments and market microstructure

4.1 Volume and maturities

As the crisis unfolded and funding markets were strained, monthly trading volume in the GCP ECB basket increased to €358 billion in June 2009 (Figure 3, panel A). Low counterparty risk due to CCP clearing as well as high requirements on collateral quality were probably fundamental to sustaining confidence in the market. Trading was not negatively affected when the ECB decided to carry out weekly refinancing operations using a fixed-rate tender procedure with full allotment on October 8, 2008, while the spread between GCP repo and the main refinancing rate became largely negative. Then, from mid-2009 until end-2010, trading volumes stagnated in the ECB basket, coinciding with the term of three one-year LTROs (long-term refinancing operation) with which the ECB injected liquidity into the market. After that, trading volume almost doubled, reaching €600 billion in October 2011.²⁶

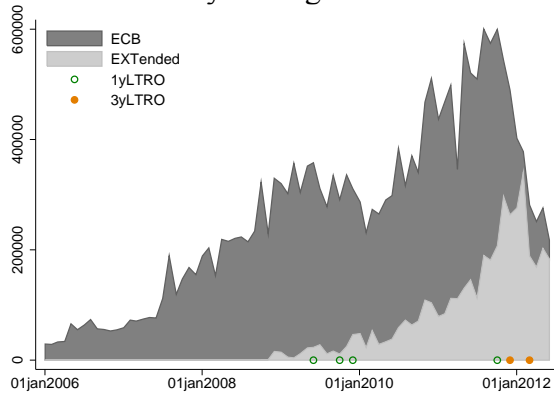
²⁵ In the ECB (EXTended) basket, the weekly average dropped from 53 (41) in the first three weeks of December 2011 to around 43 (35) in the period from March 2012 until the sample ended in mid-2012.

²⁶ For more on longer-term refinancing operations, see http://www.ecb.europa.eu/press/pr/date/2009/html/pr090507_2.en.html and

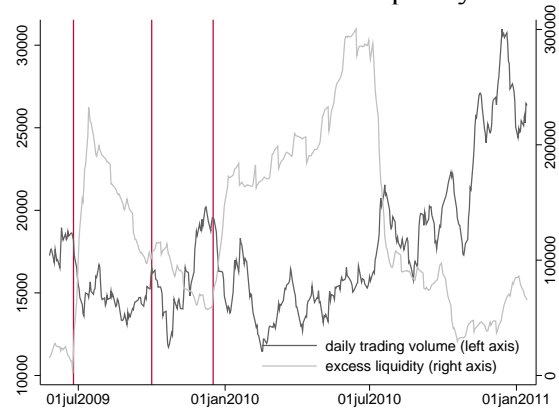
The settlement dates of the three initial LTROs were followed by a spike in excess liquidity and a drop in GCP trading volume (Figure 3, panel B). With the first and second 3-year LTRO in December 2011 and March 2012, trading volume started to contract significantly, accounting for €218 billion in the ECB basket in June 2012, a level similar to that was last seen in February 2010 at the onset of the sovereign debt crisis in the euro area.

Figure 3

Panel A: Monthly trading volumes



Panel B: LTROs and excess liquidity



Note: All values are reported in € million, repo volume is single-counted. Markers for LTROs indicate the respective settlement day in panel A. Panel B denotes 20-day moving averages of daily trading volume (both baskets combined) and excess liquidity (reserve holdings + deposit facility - reserve requirements - marginal lending facility use). Vertical lines show the settlement date of the first through the third one-year LTRO.

Table 1: Correlation between changes in excess liquidity and daily trading volume on GCP

maturity	prior full allotment	during 1-y LTROs	between LTROs	since 3-y LTROs
short-term	-0.074 *	0.018	0.079	-0.385 ***
long-term	-0.095 **	-0.196 ***	0.090	-0.057
total	-0.110 ***	-0.082	0.103	-0.327 ***
∅ excess liquidity (€ million)	508	139,680	91,964	660,151

Note: Both baskets combined. Full allotment started on October 1, 2008. The first one-year LTRO was settled on June 25, 2009 and the third one-year LTRO matured on December 17, 2010. The first 3-year LTRO was settled on December 22, 2011 and replaced the one-year LTRO settled on October 27, 2011. Short-term trading volume comprises trades with one-day maturity, and trades with a longer maturity are classified as long-term. Correlation coefficients significant at the 1%, 5% and 10% confidence level are denoted by ***, ** and * respectively.

While it is not possible to establish a causal link between monetary policy, excess liquidity and activity on the GCP market, correlations are nevertheless insightful. For this, we compare changes in excess liquidity to changes in GCP trading volume for different subsamples.²⁷ The correlation is moderately negative prior to the ECB's full allotment policy. In contrast, it was stronger during the term of the one-year LTROs as well as for short-term repos after the settlement of the first three-year LTRO (Table 1 and Figure A1). Overall, excess liquidity is

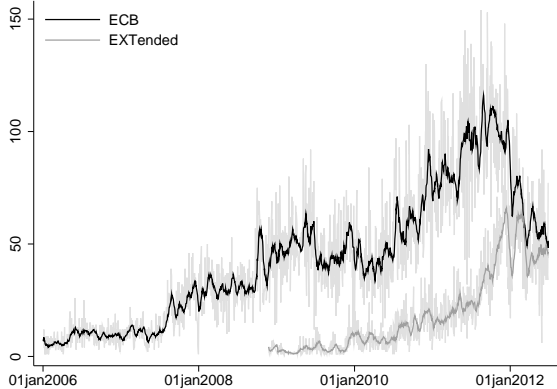
http://www.ecb.europa.eu/press/pr/date/2011/html/pr111208_1.en.html. For a general discussion on (changes in) central bank operating frameworks and collateral markets, see CGFS (2015).

²⁷ We use first differences to account for possible non-stationarity in time series, which are highly persistent. For a discussion on recent developments in excess liquidity, see ECB (2014).

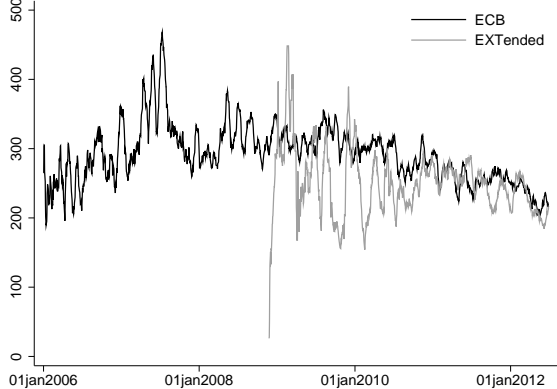
related to the use of the deposit facility (Figure A1) and seems to have crowded out some GCP trading activity when LTROs were outstanding. By contrast, in between these periods, the correlation is insignificant. Results are in line with findings by Mancini et al. (2015) that central bank liquidity tends to substitute GCP repo volume, especially after the three-year LTROs, and with the analysis by Giannone et al. (2012), who find that the positive effect of non-standard measures by the ECB on interbank lending appears to diminish after 2009 Q1.

We further analyze whether trading volume on the settlement day of main refinancing operations (MRO) or on the last day of the reserve maintenance period (MP) differs from other days. While we do not find a significant effect of MPs, possibly owing due to monetary policy fine-tuning operations, and from autumn 2008 due to the full allotment policy,²⁸ trading volume on MRO settlement days is on average 4.1% higher than the seven-day average of trading volumes around the MRO day (statistically significant at the 1% confidence level). The difference increases after the move to fixed-rate-full-allotment policy and becomes even larger after the first three-year LTRO at end-2011. The effect mainly stems from transactions with a maturity of up to one week, suggesting that banks might have had a preference for liquidity hoarding. However, the increase in the difference after the three-year LTRO is probably due to lower demand on days other than the settlement day in a saturated market.²⁹

Figure 4: Number and volume of transactions
 Panel A: Daily number of transactions



Panel B: Average volume per transaction



Note: Panels A and B denote 20-day moving averages with actual daily number of transactions depicted in light grey in Panel A. Average volume in € million.

Trading volume is directly related to the number of trades, while the average volume per trade does not show a clear trend over time, fluctuating at around €300 million (Figure 4). Daily changes are driven by the intensive margin, i.e. the change in the bank’s daily transacted repo volume, conditional on the bank having conducted transactions on the previous business day

²⁸ Fine-tuning operations are executed on an ad hoc basis with the aim of managing the liquidity situation (liquidity injection/absorption) in the market and steering interest rates. From autumn 2004 until end-2011 they were often conducted on the last day of a reserve maintenance period to counter liquidity imbalances which may have accumulated since the allotment of the last main refinancing operation (<http://www.ecb.europa.eu/mopo/implement/omo/html/index.en.html#fd>).

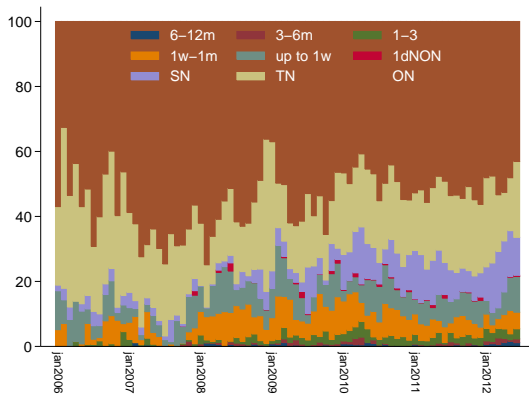
²⁹ Results are available from the authors.

(see Figure A2). Changes in the extensive margin, which reflects that a bank is no longer trading or is newly trading having not traded on the previous day, are less important but still a sizeable factor. This is somewhat different to the US tri-party repo market, where dealers typically finance the same asset classes on a daily basis but vary the exact daily amount, with changes in the extensive margin being close to zero (Copeland et al. 2010).

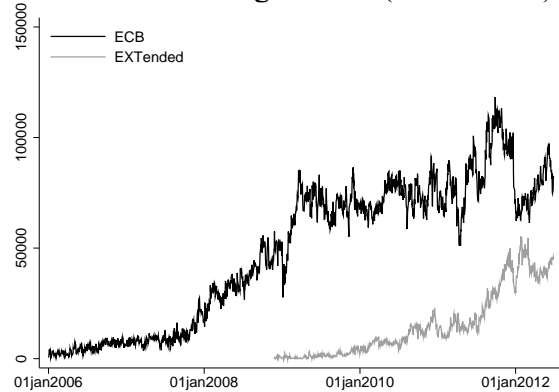
Repos are mainly short-term with daily maturities (ON, T/N, S/N)³⁰ accounting for roughly 80% of the trading volume. Maturities of one week or more, however, comprise a significant market share that regained importance after a slight contraction in market share after the maturing of the one-year LTROs. They also have a strong impact on the outstanding market volume, which stood at roughly €102 billion in the ECB basket and €36 billion in the EXTENDED basket on December 21, 2011, the allotment day of the first three-year LTRO (Figure 5).³¹

Figure 5: Maturity breakdown and outstanding volume (single-counted)

Panel A: Monthly trading volume



Panel B: Outstanding volume (in € million)



Note: Y-axis in Panel A shows percentage shares that add up to 100%. Maturity bucket up to one week excludes overnight, T/N, S/N and 1dNON maturities. 1dNON comprises maturities with an original maturity of one day where the front leg differs from overnight, T/N and S/N repos. Outstanding volume only takes into account transactions concluded during the sample period; figures are gross, not taking settlement netting into account.

At the bank level, we compute the maturity mismatch in terms of flows and stocks for each day to see how liquidity risk is allocated in this specific market (Figure A3). The difference between the 75th and 25th percentile of the daily distribution is the interquartile range, which tells us how much the maturity mismatch varies across banks. Looking at stocks, after an initial widening of the interquartile range in the first half of 2008, it narrowed considerably in the wake of the Lehman bankruptcy and the ensuing financial turmoil. However, this was a temporary development, and the reallocation of liquidity increased again in 2009 before embarking on a declining path. Similarly, flows show periods or days when banks are willing

³⁰ Overnight (ON) denotes that the front leg of the repo is settled on the day the transaction is agreed, and the term leg is one day after the front leg. For tomorrow-against-next-day (T/N), the front leg is one day after the transaction day and for spot-against-next-day (S/N) two days after, while the term leg is one day after the front leg in both cases.

³¹ To give an idea of its size, the combined outstanding volume corresponds roughly to the GDP of the Czech Republic at end-2011.

to bear heightened liquidity risk compared to the rest of the sample. The distribution of the 10% of bank/day observations with highest maturity mismatch (equal to 7 days or more) over six sub-periods tells us when reallocation of liquidity risk was more frequent (Figure A4). With LTROs and higher excess liquidity, liquidity risk-taking became more frequent. However, maturity mismatches at the bank level tend to reverse, albeit slowly.³²

Whether the GCP segment is a broad market to redistribute liquidity amongst all or most participants or whether trading is mainly confined to few, actively trading banks can be inferred from concentration measures. As shown in Figure 2, the number of market participants increases over time, and the participation rate indicates no (ECB) or a rather upward (EXTended) trend. However, this emerging picture of a broad market is qualified when looking at the share of total trading volume accounted for by the top 20 banks in terms of repo volume (79%). This points to a fairly concentrated market, possibly partly due to the initially small number of market participants. The share is even higher for sub-markets, where the market share of the respective top 20 banks (changing composition) ranges from 88% (ECB ON and T/N buyers) to 98% (EXTended S/N buyers; EXTended ON and S/N sellers).³³ Thus, the distribution of overall trading volume by bank is strongly skewed to the right (Figure A5, panel A). Over time, the share of weekly trading volume accounted for by the 20% of banks with the highest trading volume in the corresponding week was initially around 60% to 80%. It then dropped to less than 50% over the second half of 2007 and 2008, but then steadily increased again to over 80% (Figure A5, panel B).

4.2 Repo rates and a bid-ask type spread

The repo rate followed the ECB's interest policy closely within the sample period, but its position within the interest rate corridor changed markedly (Figure 6, panel A). It started in the middle of the corridor and then moved towards the deposit rate following the ECB's switch to the fixed-rate full allotment regime in October 2008 and the increase in excess liquidity.³⁴ Comparing the GCP repo rate to the EONIA, the spread moved into negative territory at the beginning of the crisis, reflecting both lower counterparty risk due to the CCP and the collateralization of the credit (Figure 6, panel B).

To measure market liquidity, we calculate a bid-ask spread that is based on concluded transactions rather than the full order book, on which we lack data (Figure 7). Since we know for each transaction whether it was initiated by the cash taker (seller) or cash provider (buyer), the difference between the volume-weighted seller and buyer-initiated repo rate can serve as proxy for the bid-ask spread.

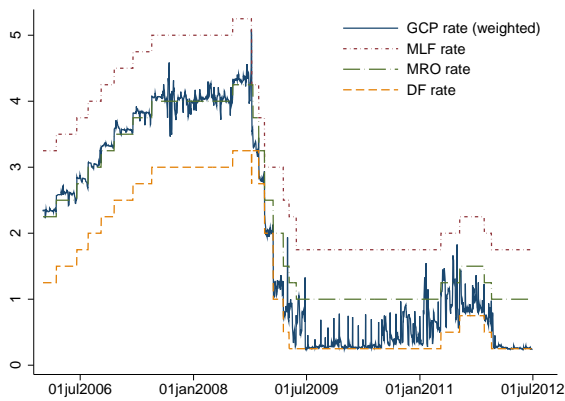
³² For banks with outstanding maturity mismatch (stock) >31 days in $t-1$, the correlation coefficient with the maturity mismatch of flows in t turns negative; the coefficient is -0.03 if the mismatch in the stock is >50 days.

³³ The top 20 share for the ECB and EXTended basket is 81% and 88% respectively.

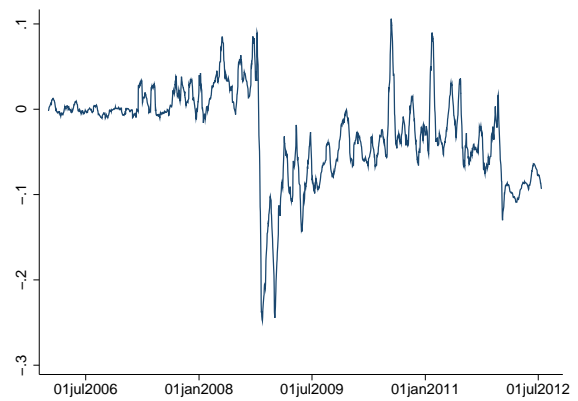
³⁴ See ECB (2014) p. 69ff for a discussion on excess liquidity and money market rates.

Figure 6: GCP overnight rate and spread to EONIA

Panel A

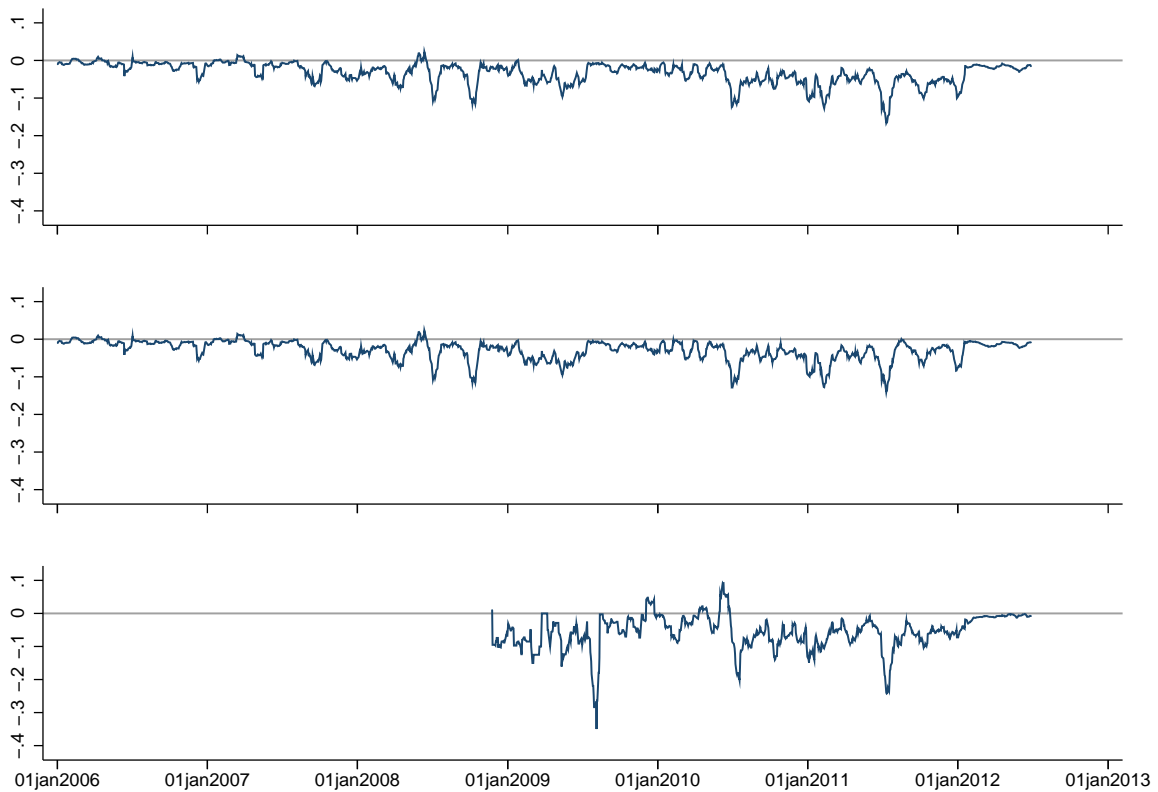


Panel B



Note: Overnight rate is volume-weighted. Panel B shows the 20-day moving average.

Figure 7: Bid-ask type spread (20-day moving average): all, ECB, EXTended



Note: Spread between volume-weighted seller (bid) and buyer (ask)-initiated repo rate.

The bid price in this case is the repo rate which sellers are willing to pay to obtain liquidity (when they make the offer quote), while the ask price is the rate at which buyers are willing to provide liquidity (when they make the offer quote). Typically, the difference between the two is negative and the spread widens the more heterogeneous the valuation of liquidity is between those seeking and those providing it. Thus the spread is larger the less liquid the market is. The spread also represents the margin for a market maker who simultaneously

quotes a bid and an ask price, thereby improving market liquidity by selling liquidity to someone urgently requiring it and buying liquidity from someone urgently selling it.

At the beginning of the crisis, spreads widened and became more volatile, but they contracted in mid-2009, coinciding with the first one-year LTRO. In 2010, with the sovereign debt crisis, spreads turned more negative, also in the days preceding the maturity of the above-mentioned LTRO on July 1, 2010, and do not seem to be positively influenced by the benign EBA stress test results. On March 3, 2011, the ECB announced the continuation of the fixed-rate full allotment procedure and, after an unusual rise in the spread on the following day (especially in the EXTended basket), the bid-ask spread became smaller and less volatile with the three-year LTROs at the end of the same year. The next subsection investigates banks' trading strategies and how they relate to the bid-ask spread.

4.3 On buyers, sellers and market makers

GCP is a cash-driven market in which banks raise funds, extend liquidity or engage in both activities, either because of differing liquidity needs between or within days or to earn the spread, thereby acting as market makers. In addition, having two market segments characterized by different collateral pools, the GCP market offers the possibility to trade cross-basket, i.e. between the segments. This may allow banks to take advantage of price differences or to upgrade their collateral pool.

First, we look at the net cash obtained by a bank across both Eurex Repo baskets. We define the net cash flow as inflows minus outflows of cash (i.e. repos minus reverse repos) generated by transactions concluded on a given day (excluding flows from maturing transactions concluded in the past).³⁵ A positive position means that a bank is on total borrowing liquidity, while a negative position stands for extending liquidity. Initially, and also after the onset of the crisis until mid-2009, lenders were ready to provide increasing amounts of liquidity and cash takers were able to fund large positions (Figure 8, panel A).³⁶ Ever since, net positions in absolute terms have decreased and the interquartile ranged has narrowed.

Whether the net cash position is based on repos or reverse repos only, or whether banks engage in both lending and borrowing the same day, can be deducted from the net-to-gross (ntg) ratio for each bank (see also Agueci et al. 2014). It is defined as net cash over the sum of inflows and outflows of bank j at time t , or formally

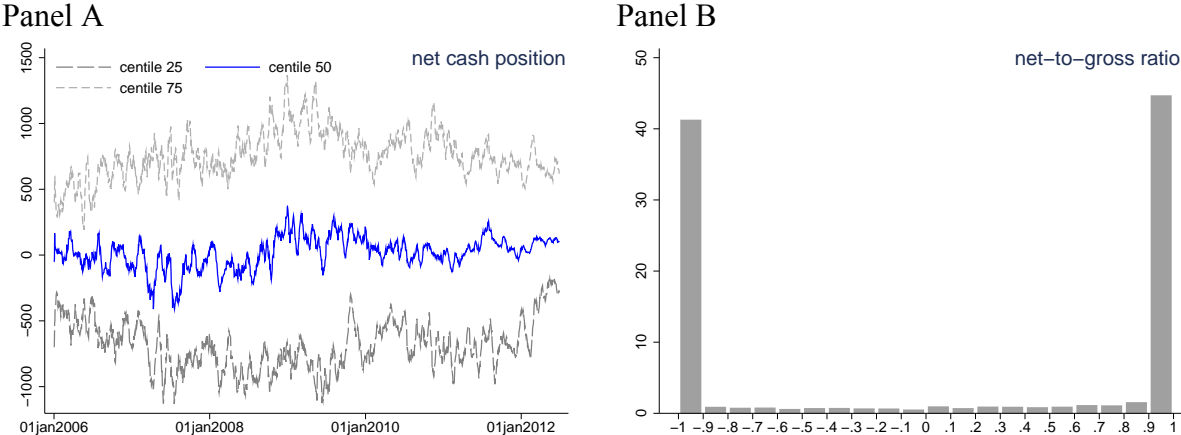
$$ntg_{jt} = \frac{\sum_{i=1}^2 (repo_{ijt} - reverse\ repo_{ijt})}{\sum_{i=1}^2 (repo_{ijt} + reverse\ repo_{ijt})} \quad (1)$$

³⁵ We record flows when transactions are concluded, not settled, and use this same approach in the remainder of this paper. The reason is that banks have a (future) payment or delivery obligation as soon as they enter a repo agreement. As a robustness check, we redo the same analyses taking the purchase date, i.e. the settlement date of the front leg, as reference instead of the day the transaction is concluded. Our results continue to hold in terms of quality and are also quantitatively virtually unaffected by this alternative approach.

³⁶ This also can be observed by an initial increase in the average loan amount (see Figure 4).

with i being the collateral basket. The ratio ranges from +1 (repo only) to -1 (reverse repo only). Over the full sample, roughly 40% of net cash positions are based on repo only (pure cash-taking), 40% on reverse repo only (pure cash-providing), and only less than 20% are related to instances where a bank is conducting both repo and reverse repo operations the same day (panel B). By contrast, in the US GCF market, 67% of banks conduct both repo and reverse repo transactions when trading on a given day, while 23% conduct only repos and 10% only reverse repos (Agucci et al. 2014). Especially banks with overall low trading volume tend to either borrow or lend cash, while offsetting transactions are relatively more important among banks with higher trading volume (Table A1). Pure strategies have, however, become less dominant over time and there is heterogeneity both across and within banks over time and baskets (Figure A6 and Figure A7, panel A). Some banks predominantly act as liquidity providers, some as borrowers and others are both lenders and borrowers at different points in time. Most banks also conduct both repos and reverse repos on some trading days, but no bank acts as an explicit market maker.

Figure 8: Interquartile range of net cash positions and distribution of net-to-gross ratios



Note: Panel A depicts the 20-day moving average for the 25th, 50th and 75th percentile of the daily net cash positions. Panel B shows the share in percentage of net-to-gross ratios belonging to a certain net-to-gross bucket (x-axis) based on bank/day observations. The ratio ranges from +1 (repo only) to -1 (reverse repo only).

In the GCF market in the US, net lenders and net borrowers are quite consistent in their strategies, meaning that a bank that borrows (lends) today is likely to do so tomorrow as well. This can be confirmed for the GCP market, where the probability of sticking to the same strategy is 89.6% for net borrowers and 88.3% for net lenders.

To see whether market liquidity is related to market structure, we compare the bid-ask spread with two simple indicators. First, we look at the extent to which banks make use of both repo and reverse repo transactions on a given day, thus potentially increasing market liquidity. Second, we measure how much of the daily trading volume is initiated by cash takers making the first quote. This share serves as a rough proxy for a demand or supply overhang that might impinge on the bid-ask spread.

Daily trading volume due to both repo and reverse repo operations of a bank slightly increases over time from almost 0% to roughly 15% (Figure 9). The measure is computed as sum over banks j at time t with netted volume at the bank level being defined as

$$netted\ volume_{jt} = \frac{(inflow_{jt} + outflow_{jt}) - (inflow_{jt} - outflow_{jt})}{(inflow_{jt} + outflow_{jt})} \tag{2}$$

thus basically deducting from a bank’s total volume the amount that cannot be netted.³⁷ By comparison, the share of cash taker-initiated trading volume fluctuates strongly over time, mostly in a range of 40% to 60%. Both the share of netted volume and – to a lesser extent – our proxy of demand or supply overhang are negatively correlated with the bid-ask spread, meaning that the spread turns more negative the higher the share of netted volume and seller initiated volume is (Table 2).³⁸ This finding may be interpreted as banks having a particular incentive to engage simultaneously in repo and reverse repo transactions, i.e. to act as market maker, the more negative the spread is, thereby earning the rate differential. It also reveals that market making activity in aggregate is not sufficient to compress the spread.

Figure 9: Development in volumes

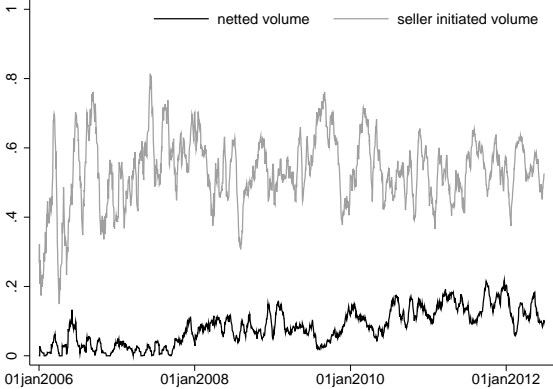


Table 2: Correlations with bid-ask spread

	bid-ask spread
share of netted volume	-0.21 ***
share seller-initiated volume	-0.04 *
N	1621

Note: Both baskets combined. Time series in Figure 9 are 20-day moving averages. Table 2 shows correlation coefficients (note that the bid-ask spread is usually negative) *** (*) denotes significance of p-value at the 1% (10%) confidence level.

5. Going bilateral: when, how, why?

While the GCP market is characterized by an electronic trading platform for anonymous repo transactions, the GCP segment also offers the possibility to clear bilaterally agreed transactions that meet the market’s requirements via the CCP.³⁹ If this option is used, the

³⁷ In this case, netted volume refers to overlapping repo and reverse repo transactions without distinguishing between baskets and is thus different from netting rules applied to settlement day netting and from the rules for financial accounting purposes.

³⁸ This result is driven by the ECB basket, while there is no strong negative correlation between the bid-ask spread and netted volume in the EXTended basket. The correlation between market making and the bid-ask spread is significant during the term of the one and three-year LTROs and at the beginning of the sample period.

³⁹ In bilaterally agreed transactions, a market participant uses the pre-arranged market functionality (available since the inception of the trading system) to make an addressed offer to another market participant, after having agreed on the terms of the transaction. Since 2013, a transaction can also be brokered by a registered broker

transaction details are known to the contracting parties, but the details of the repo are posted on the trading platform in an anonymous form. The advantages of such transactions are that contract terms can deviate from the standardized ones traded anonymously, especially concerning non-standard maturities. For those, the GCP market might not be liquid, and it can be preferable for banks to find a counterparty bilaterally, relying on GCP for clearing and settlement and taking advantage of reduced counterparty risk.

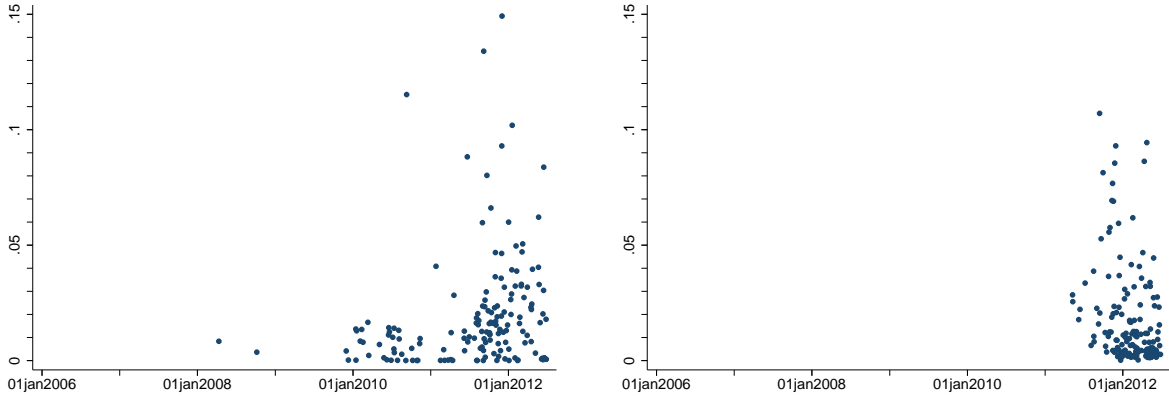
This option was rarely used until well into 2011, and gained importance in late 2011 and the first half of 2012 (Figure 10). Overall, there were 588 such transactions in the Euro (ECB basket: 295; EXTended basket: 293), amounting to up to 15% of the daily trading volume.⁴⁰ With 50 banks,⁴¹ over half of market participants were the counterparty in bilateral deals, although the frequency differs from over 100 transactions to a single transaction per bank.

Maturities are longer-term, exceeding those observed for the anonymous GCP market. Of the bilaterally agreed repos, roughly 87% (95%) had a maturity of one week or more in the ECB (EXTended) basket, compared to 20% (15%) in the full sample. Considering that bilaterally agreed repos became more frequent at the end of 2011, this may suggest a connection with the ECB’s three-year LTROs announced and conducted in December of that year. The somewhat earlier rise in activity may result from early market rumors.

Figure 10: Share of daily trading volume due to bilaterally agreed transactions

Panel A: ECB basket

Panel B: EXTended basket



Note: Only shares greater than zero are shown.

In bilaterally agreed repos, the transaction partners know each other, and this offers insight on whether relationships between banks play a role. Specifically, for each bank conducting such transactions we look at the number of different counterparties. If the bulk of one bank’s repos is with few counterparties, we deduce that a relationship exists between banks that favors

which itself is not allowed to be a market participant. The broker makes a broker offer, which is equivalent to two addressed offers, to both market participants who do not know each other but who are known to the broker and Eurex. In both cases, transaction partners are referred to as aggressors and transactions are listed in anonymous form in the system. Broker offers have rarely been used to date, according to Eurex.

⁴⁰ There were also 120 bilaterally concluded transactions in US dollar, which are disregarded in this analysis.

⁴¹ Of which 43 in the ECB and 29 in the EXTended basket (some banks used bilateral deals in both baskets).

lending and borrowing. Indeed, most banks contract with few others when going bilateral, showing the importance of relationships (see Table A2).

6. Cross-basket activity: getting from the rich, giving to the poor?

Market participants are likely to follow a pure buy or sell strategy on a given business day, but observations in which a bank conducts both repo and reverse repo transactions increased to approximately 15% of daily trading volume towards the end of the sample period (see Section 4.3). Those observations also comprise instances when banks lend and borrow in different baskets. Such cross-basket trading can go either way, borrowing in the narrow ECB basket and extending liquidity in the wider EXTended basket or vice versa. The first strategy might be related to banks taking advantage of the yield spread between the two baskets. The second could be reconciled with some kind of collateral upgrading, in which banks obtain funding secured by collateral from the lower quality EXTended basket and reinvest the cash in the ECB basket, obtaining higher quality collateral. Such behavior possibly arises from the need to deliver high quality collateral in another transaction without having it in stock, or more recently (not covered by our sample period) to improve the Liquidity Coverage Ratio (LCR) by swapping non-eligible assets under regulatory rules for high quality liquid assets.⁴²

Cross-basket trading can be captured by the swap ratio, which is defined as

$$\text{swap ratio}_{jt} = \frac{|\sum_{i=1}^2(\text{inflow}_{ijt} - \text{outflow}_{ijt})|}{\sum_{i=1}^2(|\text{inflow}_{ijt} - \text{outflow}_{ijt}|)} \quad (3)$$

for bank j at time t with i indicating the basket (see Agueci et al. 2014). When a bank has no offsetting positions across baskets, the swap ratio is 1; and it is 0 if the net inflow in one basket perfectly matches the net outflow in the other basket. In the sample, cross-basket activity occurs in less than 7% of bank/day observations, being the dominant strategy in 3% of observations (swap ratio < 0.5; see Table 3).

These are lower values compared to the GCF market, where 25% of bank/day observations show a swap ratio of 0.85 or less, and it is the dominant strategy for 10% (Agueci et al. 2014). However, it has to be taken into account that swap ratios in GCP refer to baskets defining a broad set of eligible collateral, while in GCF they refer to 10 general asset classes for collateral, such as different categories of agency and Treasury bonds, based on which dealers can negotiate (Agueci et al. 2014).

⁴² The LCR is designed to ensure that stressed net outflows over the coming 30 days are covered by a stock of high quality liquid assets (HQLA), and its phase-in started in 2015 (<http://www.bis.org/publ/bcbs238.htm>). While swapping non-HQLA for cash via a repo with a maturity over 30 days in the EXTended basket already improves the LCR, banks have an incentive to earn interest on the liquidity received by reinvesting it via a reverse repo in the narrow, now LCR-aligned, ECB basket. The incentive would increase if market haircuts were to exceed regulatory ones, as the reverse repo would be higher collateralized. However, future regulatory requirements such as the Leverage Ratio and the Net Stable Funding Ratio make repos more costly.

Figure 11: Cross-basket activity

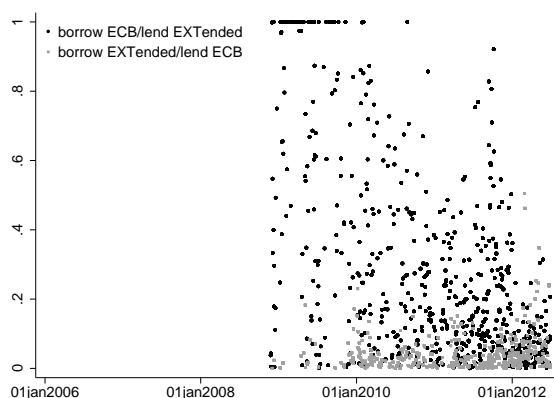


Table 3: Swap ratio

percentile	swap ratio
1	0.17
2	0.33
3	0.48
4	0.66
5	0.82
6	0.99
7	1.00
N	27,835

Note: Sample begins with the introduction of the EXTended basket in November 2008. Black markers indicate borrowing ECB / lending EXTended as share of daily EXTended lending, grey markers borrowing EXTended / lending ECB as share of daily ECB lending. For 92 observations the denominator of the swap ratio is zero.

Borrowing in the ECB basket and lending in the EXTended turns out to be more common than the opposite operation (observed on 604 business days compared to 379 days) and accounts for a larger share of lending (Figure 11).⁴³ So cross-basket arbitrageurs seem to reallocate liquidity from the ECB basket segment to the EXTended basket segment.

7. Concluding remarks

At the aggregate level, our analysis revealed that trading is influenced by excess liquidity, on which central bank liquidity has an impact. Particularly during the term of long-term refinancing operations provided in the wake of the crisis, excess liquidity may have crowded out some activity in GCP. With high excess liquidity, both the level and the volatility of the bid-ask spread decline. At the micro level, a bank mainly either borrows or lends liquidity on a given day. Arbitrage or market maker activity within this market – measured by offsetting repo and reverse repo operations – are of minor, although increasing, importance. This activity is partly due to cross-basket trading when banks borrow liquidity in the ECB basket and lend it in the wider EXTended basket, possibly earning the repo spread, or do it the opposite way, upgrading their collateral quality. Further, long-term central bank liquidity is positively related to the number of bilaterally agreed repos, which are, on average, of a longer maturity than anonymously conducted repos during the same period. Although relationship banking plays a role, market participants take advantage of CCP clearing and standardized collateral baskets.

Further analyses included in the appendix show that around the Lehman bankruptcy no specific patterns concerning trading volume or repo rates can be found for single banks. By contrast, since the crisis we observe few instances when repo rates exceed the rate charged for using the ECB's marginal lending facility. In some cases this may be due to banks domiciled

⁴³ 604 (379) business days are 65.5% (41.1%) of the sample since the introduction of the EXTended basket.

outside the European Monetary Union, but this cannot account for all observations. GCP offers the advantage of anonymity also vis-à-vis the central bank, which sometimes seems to be priced higher than a positive repo rate differential to the MLF. Besides anonymity, market participants benefit from settlement netting, which provides efficiency gains and involves lower collateral needs. Net cash flows amount to less than 40% of gross flows towards the end of the sample period.

Overall, this study contributes to the small but growing literature on repo market developments during the crisis. In comparison to bilateral and tri-party repos not cleared by CCPs, the Eurex GCP segment proved to be remarkably stable. Our analysis suggests that, in addition to the collateral pooling, the central counterparty clearing and the possibility to reuse collateral both within GCP and for monetary refinancing operations,⁴⁴ the particular market microstructure also contributed to the market's resilience.

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⁴⁴ A further important factor may have been the exclusion of some securities from the eligible collateral pool as the crisis evolved, which is equivalent to a haircut of 100%. There are, however, limitations to a pre-post crisis evaluation of the GCP segment, as the market was still very small at the onset of the financial turmoil.

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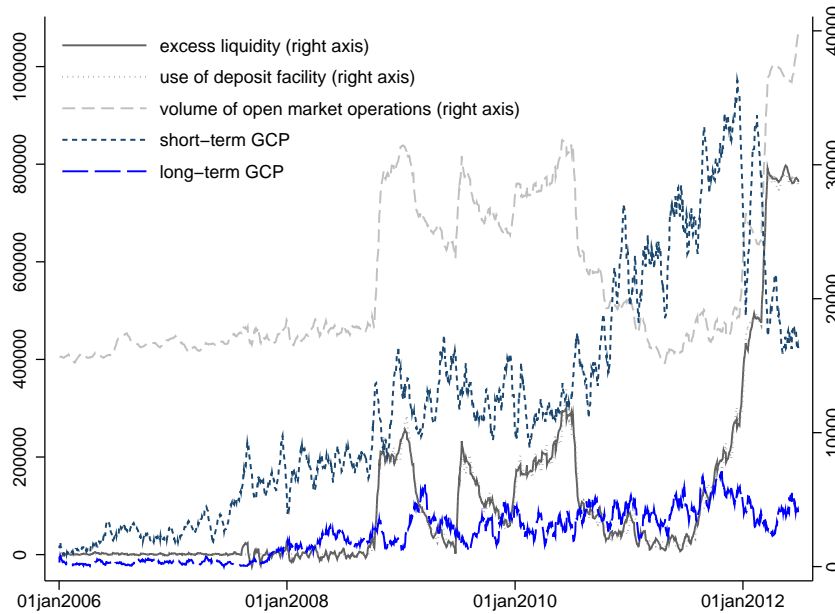
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Appendix

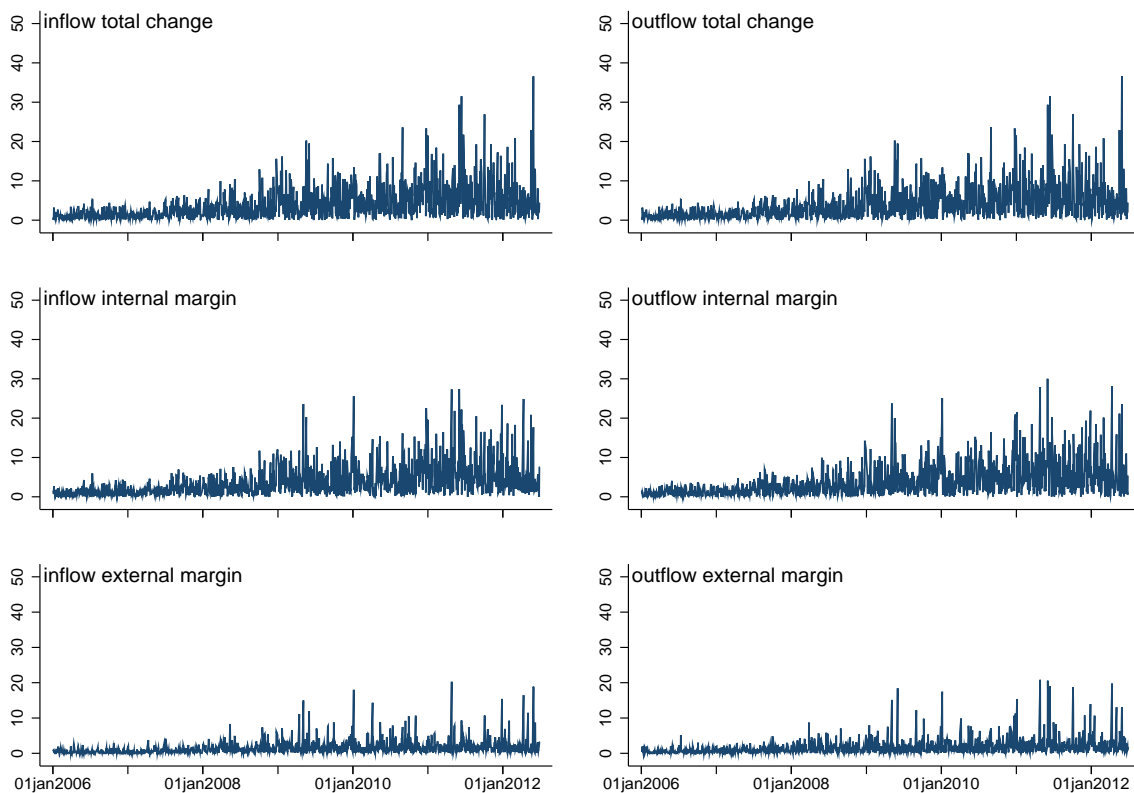
(A) Tables and figures

Figure A1: GCP trading volume, central bank liquidity and excess liquidity over time



Note: Volume in € million. Time series are 20-day moving averages.

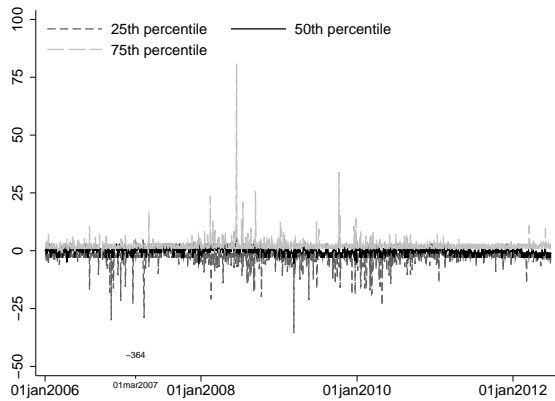
Figure A2: Sum of absolute daily changes in volume, intensive and extensive margin



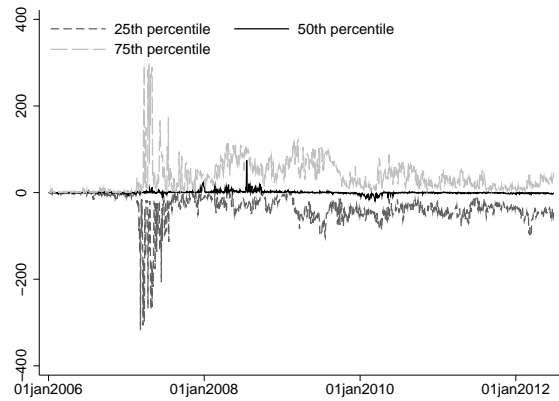
Note: All market participants, both baskets. Y-axis in € billion.

Figure A3: Maturity mismatches (interquartile range)

Panel A: flows

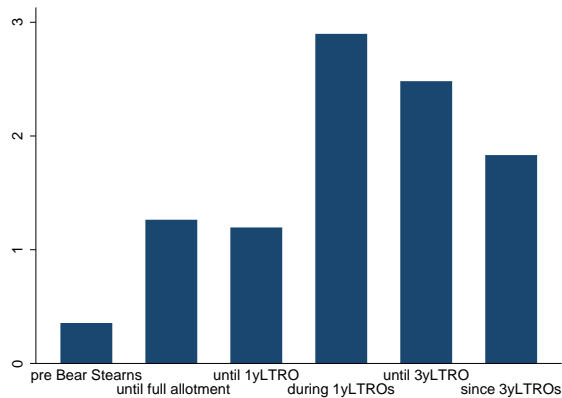


Panel B: stocks



Note: The maturity mismatch is calculated for each bank and day as the volume-weighted difference between the days to maturity of outflows and inflows. Flows only include new transactions on a given day, stocks include all outstanding transactions on that day. Y-axis denotes the maturity mismatch in calendar days with a positive (negative) value, signaling that the outstanding maturity of outflows exceeds (is below) the outstanding maturity of inflows. If a bank reports only inflows or outflows on a given day, the corresponding maturity is taken into account and the missing value is set to zero (e.g. inflows only would correspond to negative maturity mismatch). If both inflows and outflows are missing, the observation is dropped. Stocks only take into account transactions concluded during the sample period.

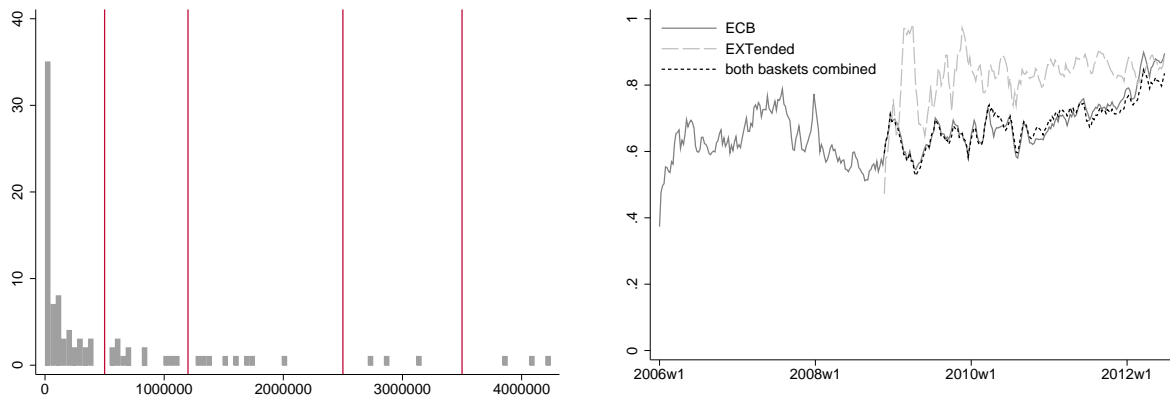
Figure A4: Distribution of instances of high maturity mismatches over time (flows)



Note: The chart shows the distribution of the 10% of bank/day observations with the highest maturity mismatch over the sample period. The 90th percentile of the distribution is equal to an approximate positive maturity mismatch of 7 days.

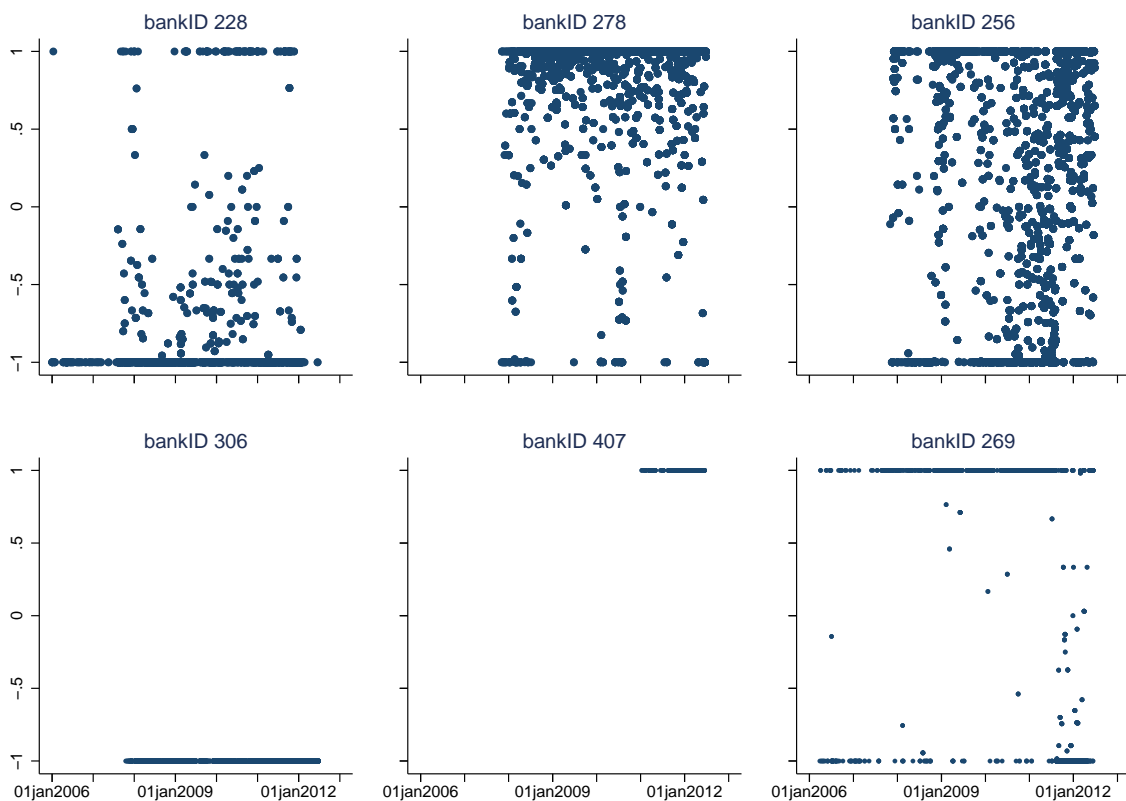
Figure A5

Panel A: Distribution of bank trading volume Panel B: Share of top 20 in trading volume



Note: Panel A depicts the histogram of bank trading volumes over the sample period (total amount for each bank, both baskets combined). The y-axis shows the number of banks, the x-axis trading volume in € million. Vertical lines indicate cut-off values defining the five trading volume buckets used in Table A1. Panel B shows the share of weekly trading volume accounted for by the 20% of banks with the highest trading volume in the relevant week. The 20% threshold relates to the number of banks that had been active in the relevant basket until the observation date. Time series are 4-week moving averages.

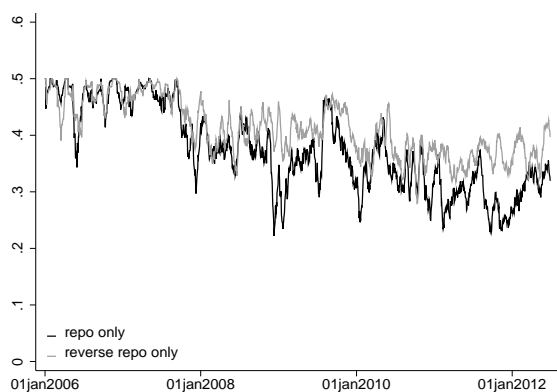
Figure A6: Net-to-gross ratio by bank (selection – ECB basket)



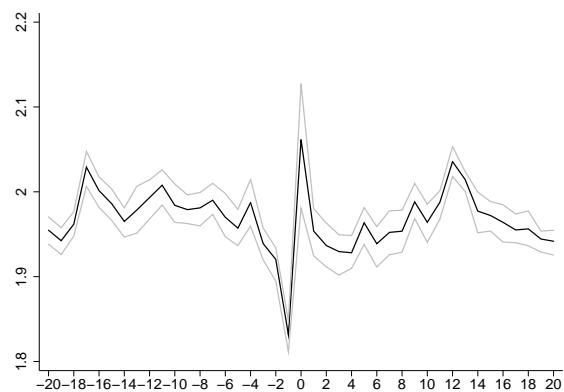
Note: Net-to-gross ratios are calculated on a daily basis and range from +1 (repo only) to -1 (reverse repo only). Trading strategies can roughly be categorized into six categories (starting from the upper left graph in clockwise order): mainly reverse repos with occasional repos; repos with occasional reverse repos; both repos and reverse repos; mainly reverse repos or repos only; repos only; reverse repos only.

Figure A7

Panel A: Share of (reverse) repo only



Panel B: Repo rate around quarter ends



Note: Panel A shows pure repo or reverse repo strategies as a share of daily trading volume. Time series are 20-day moving averages. Panel B shows the average of event-time trading day overnight repo rates (volume-weighted) as well as the 25th and 75th percentile of the distribution of daily overnight repo rates over the sample period. Day zero corresponds to the last trading day of a calendar quarter.

Table A1: Incidence in percentage terms of net-to-gross ratios by banks' trading volume

ntg-bucket	$i \leq 500\text{bn}$	$500\text{bn} \leq i < 1200\text{bn}$	$1200\text{bn} \leq i < 2500\text{bn}$	$2500\text{bn} \leq i < 3500\text{bn}$	$i \geq 3500\text{bn}$
$-1 \leq x \leq -0.75$	43.81	45.49	48.58	28.25	32.26
$-0.75 < x \leq -0.25$	1.4	3.4	4.35	1.54	7.33
$-0.25 < x \leq 0.25$	1.32	3.23	4.45	1.48	7.45
$0.25 \leq x \leq 0.75$	1.55	3.48	5.54	5.44	11
$0.75 \leq x \leq 1$	51.92	44.4	37.08	63.29	41.96
column sum	100	100	100	100	100

Note: Both baskets combined. For each bank the cumulative trading volume (i) over the sample period is calculated and assigned to one of the five buckets with cut-off values derived from the distribution of banks' trading volume (Figure A5, panel A).

Table A2: Number of bilaterally agreed repos and different transaction partners by bank

bankID	n° (counterparties)	n° (transactions)	bankID	n° (counterparties)	n° (transactions)
128	3	7	306	1	2
129	4	16	309	6	86
130	8	49	311	1	3
141	4	7	318	2	4
208	7	32	329	1	4
217	25	158	333	1	1
220	8	32	343	5	11
222	19	65	357	2	3
226	7	17	385	1	1
236	14	51	389	2	7
242	7	70	391	1	2
244	8	15	392	1	35
250	6	57	396	1	1
253	7	34	397	1	1
256	11	46	404	2	22
257	8	18	411	1	1
259	2	2	413	2	2
261	3	15	422	1	1
263	2	9	423	1	1
269	1	1	428	5	173
271	4	7	429	1	1
274	1	2	430	1	2
277	1	7	432	1	1
278	3	37	433	7	32
280	4	19	436	1	6

Note: Both baskets combined.

(B) Further selected aspects

A short primer on repos

With a repo a borrower (cash taker) sells a security (collateral) to a lender (cash provider) at time t and agrees to repurchase the security for an agreed price at $t+n$. The (usually positive) difference between the repurchase price and the original sale price is the paid interest or repo rate. As such, repos are essentially secured loans with the collateral legally changing ownership (Bakk-Simon et al. 2012). Like bank loans in which short-term deposits are used to finance longer-term assets, repos entail a maturity transformation as short-term borrowing is secured by longer-term collateral. Repos are often short-term, but can be rolled over. Spot-against-next-day (S/N; around 40% of average daily turnover in bilateral repo), tomorrow-against-next-day (T/N; 20%) and overnight (ON; 15%) account for the bulk of transactions in the euro-denominated European repo market (ECB 2012).

Repos can be bilaterally conducted or involve intermediaries such as a tri-party agent or a CCP. In the latter case, the CCP steps in as legal counterparty; thus, two separate contracts between borrower and CCP on the one hand and lender and CCP on the other hand are written (BIS 2010). A repo is said to be cash-driven when obtaining funding is the objective. A special form is general collateral (GC) repo, in which the cash provider only knows that the collateral meets the credit and liquidity criteria based on a defined collateral basket, but does not know ex-ante the specific collateral it receives. GC repo comprises 22.3% of electronic repo trading or 7.4% of overall repo trading in Europe (ICMA 2012), although probably accounting for a higher share in the European euro repo market. By contrast, when the main purpose of a (reverse) repo is to obtain a specific security pledged as collateral, one speaks of collateral-driven or special collateral (SC) repos.

Survey evidence highlights the increasing importance of repos conducted via CCPs in Europe. According to a panel of 105 credit institutions, 55% of all euro-denominated repo transactions are CCP cleared, with the trend increasing (ECB 2012, 2010). Especially maturities up to one week show a strong incidence of CCP clearing. Based on a different sample, a survey conducted by the European Repo Council reports a lower number of CCP use, comprising 19% (automatically cleared via CCP) or 26% (total CCP cleared including post-trade CCP clearing) of repo transactions (ICMA 2012). Despite differences, there is a common view that both long-term and short-term trends, due to cost and regulatory pressure as well as risk aversion, favor electronic trading, particularly cleared via CCP.

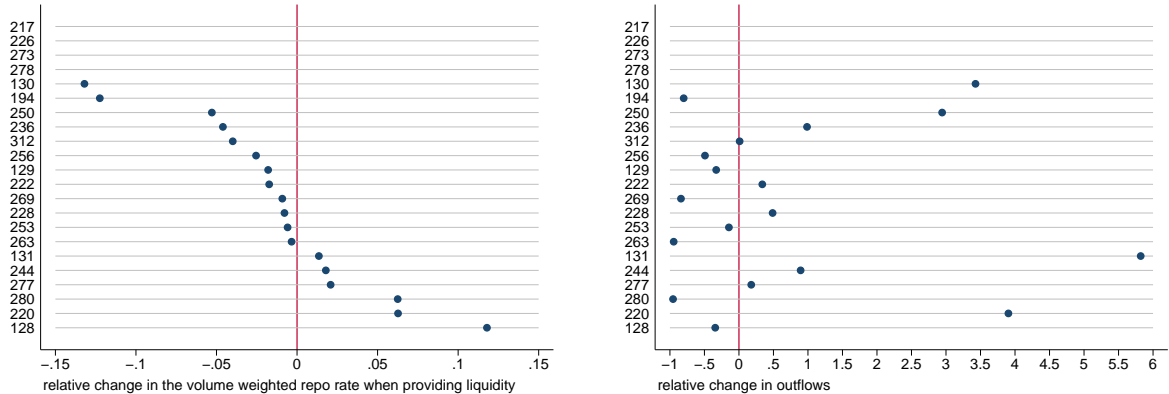
Lehman: event study

When Lehman Brothers Holdings Inc. filed for bankruptcy on September 15, 2008, the ongoing financial crisis reached a turning point. It had severe and in some cases long-lasting repercussions for funding markets, inducing widespread insecurity and a loss of confidence in

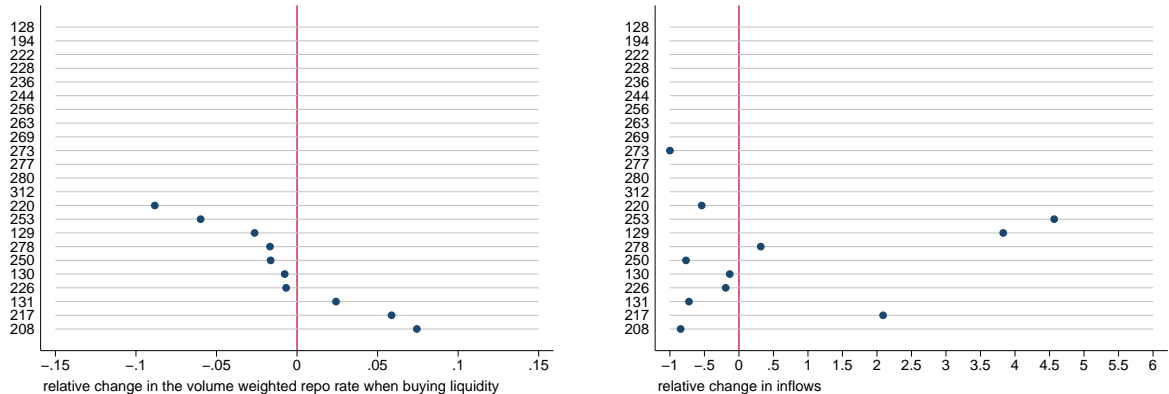
counterparty creditworthiness. To see how market participants in the anonymous GCP market responded to this galvanizing moment, we conduct a pre-post analysis along the lines of Copeland et al. (2010), focusing on the overnight segment. Using a time window of one month before and one month after the Lehman bankruptcy, the change in repo rates paid or received for funding and the change in funding volume itself is computed for each bank trading pre-Lehman.

Similar to what Copeland et al. (2010) found with respect to haircuts and volumes in the US tri-party market, no clear relationship emerges between repo rates and trading volume in the GCP segment (Figure B1). While some banks pay more for liquidity post-Lehman, the volume they are raising is not always shrinking. Other banks are able to refinance themselves at more advantageous terms after the event than prior to it, but not all of them also increase the volume borrowed. Likewise, among banks, which are able to charge more (less) for liquidity provision post-Lehman, some expand (shrink) their loan book while others do not.

Figure B1: Comparing one month before and one month after the Lehman bankruptcy
 Panel A: Change in repo rate (cash provider) Panel B: Change in volume (cash provider)



Panel C: Change in repo rate (cash taker) Panel D: Change in volume (cash taker)



Note: Bank identifier on y-axis. The change in repo rate or volume is computed as the difference between the post- and pre-Lehman value over the pre-Lehman value, with 1 (-1) indicating a 100% increase (decrease). A value of -1 in panel B and D means that no trading occurred post-Lehman. Only banks actively participating in the overnight segment in the month before the Lehman bankruptcy are included. Banks in panels A/B and C/D are sorted according to the change in repo rate.

As pointed out by Copeland et al. (2010), part of this heterogeneity might be due to differing outside options we do not observe. Liquidity-constrained banks will be more willing to pay higher rates and even increase their borrowing at the given rate, while banks with other options may switch to alternative funding sources or reduce their funding needs. When comparing GCP to the US tri-party market, however, it has to be borne in mind that trading on the Eurex GCP market is anonymous; thus, single market participants cannot be discriminated.

GCP as a substitute for the marginal lending facility (MLF)?

GCP is an important funding market for euros, and repo rates are strongly influenced by monetary policy. Usually, overnight rates move within the corridor of the marginal lending facility as the upper bound and the deposit facility as the lower bound (see Figure 6). However, there are instances where the repo rates on some transactions exceed the MLF rate, although collateral requirements in GCP are more restrictive than in monetary policy operations. This leaves us with two explanations: (i) either the cash taker is a bank domiciled outside the European Monetary Union and thus has no access to the ECB's standing facilities or (ii) banks are reluctant to tap the MLF charging a lower rate due to reputational concerns vis-à-vis the ECB or ensuing stricter oversight. Should there be a stigma effect, banks may be willing to pay more in GCP as they prefer not to reveal their liquidity needs to the central bank.

Table B1: Transactions with repo rate higher than MLF rate

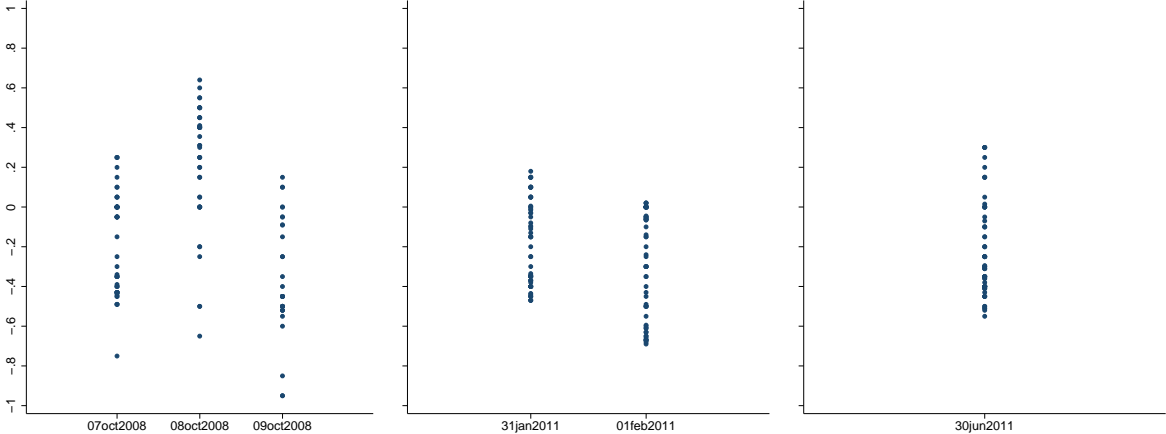
Panel A			Panel B		
date	n° transactions	%	bankID	n° transactions	%
07oct2008	10	13.70	129	9	12.33
			130	11	15.07
08oct2008	31	42.47	217	9	12.33
			220	7	9.59
09oct2008	3	4.11	226	6	8.22
			253	1	1.37
31jan2011	15	20.55	256	4	5.48
			263	4	5.48
01feb2011	3	4.11	278	9	12.33
			280	6	8.22
30jun2011	11	15.07	343	2	2.74
			406	4	5.48
			413	1	1.37
sum	73	100	sum	73	100

In our sample, we observe such high overnight rates on six business days: from October 7 to 9, 2008, from January 31 to February 1, 2011, and on June 30, 2011 (Table B1). Of those days, the first three were characterized by cuts in the official rate, with the MLF rate going

down from 5.25% on October 7 to 4.75% on the following day, and to 4.25% on October 9 (narrowing of the corridor).

Although we are not able to check whether repo rates exceeding the MLF rate are driven by foreign domiciled banks or stigma effects, both explanations would be applicable in this specific case. At that time GCP had registered two banks from the UK, and while the stigma effect attached to the MLF might have been reduced during the general turmoil, some banks may still have restrained from using it. Overall, in 73 repos, 13 different cash takers were paying up to more than 60bp in excess of the MLF rate (Figure B2). It should also be noted that during the sample period, less use was made of the MLF in general for covering short-term liquidity needs at the end of reserve maintenance periods, as the Eurosystem employed fine-tuning operations to smooth interest rates and the full allotment policy provided abundant liquidity from autumn 2008.

Figure B2: Spread between repo and MLF rate



Note: Y-axis displays the difference between the overnight repo rate and the MLF rate in percentage points. Each observation represents one repo transaction. No distinction between baskets is made.

Settlement netting and trading activity at financial reporting dates

Netting of repo and reverse repo trades is of increasing importance to market participants to economize on costs and collateral. It represents an advantage given the widespread use of secured funding and regulatory requirements to hold certain amounts of unencumbered and liquid assets. In this regard, one has to distinguish between netting under settlement netting rules (the repo market’s master netting agreement) and netting according to accounting rules and from the rules governing netting for regulatory purposes.

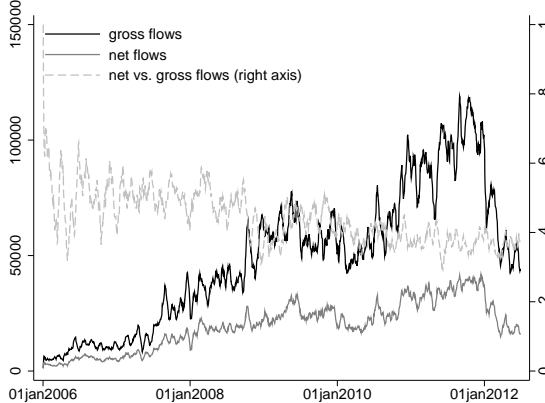
Eurex Clearing nets, as CCP, each market participants’ daily cash flows in a given basket and currency with only the overhang being settled. The exception is the front leg of overnight transactions, which is processed under immediate settlement instructions and settled gross within 30 minutes during the same day settlement period. Net cash flows are therefore

significantly lower than gross flows (Figure B3) despite the large share of overnight transactions.

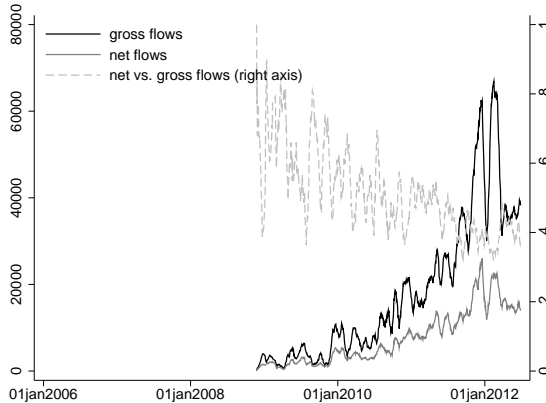
According to regulatory requirements, which determine the basis for capital charges, repos conducted via CCPs were exempt from capital requirements under Basel II and its translation into EU law. From this standpoint, netting was irrelevant during our sample period. The leverage ratio agreed under Basel III rules and first reported in December 2010 for supervisory monitoring is also likely to have had a limited impact on trading behavior, as it is not yet a binding standard and mandatory public disclosure only started in January 2015.

Figure B3: Daily cash flows (inflows and outflows)

Panel A: ECB basket



Panel B: ECB EXTended basket



Note: Cash flows in € million; figures are aggregated over market participants. Daily gross flows are the sum of bank-specific inflows and outflows of both the front and term leg of transactions. Net flows are flows after settlement netting, with bank-specific daily inflows and outflows of both front and term legs being netted except for the front leg of overnight transactions, which are settled in real time. Time series are 20-day moving averages.

The repo values to be reported in financial statements depend, however, on accounting rules. These differ with respect to netting provisions depending on the framework applied. In general, under US GAAP, netting is less restrictive than under IFRS or HGB in Germany, so that repos inflate the size of the balance sheet to a lesser extent in the US than in Europe.

At the latest since Lehman Brothers’ improper accounting of repos as true sales, via the use of repo 105 and repo 108 (Valukas 2010), the importance of short-term borrowing for financial statements and regulatory figures has become known to a wider public. Repo transactions are related to short-term wholesale refinancing risk and increase the balance sheet of the cash taker, as the borrowed amount will be booked as asset and liability, and the security pledged as collateral remains on the books of the cash taker. Repo increases the borrower’s leverage, but it also reduces liquidity buffers for cash lenders. Hence, banks – and reporting firms in general – may have an incentive to (temporarily) reduce their repo activity when it has to be reported as end-of-period value on reporting dates. In the case of quarterly financial statements, a legal way of doing this is to reduce short-term repo borrowing at quarter end, while resuming higher borrowing thereafter, or to engage in reverse repos qualifying for netting under accounting rules. End-of-quarter short-term repo borrowing will then be lower

than the average over the quarter, which has been documented for the US (WSJ 2010, Owens and Wu 2014) in the run-up to and during the current crisis. This led the Securities and Exchange Commission (SEC) to propose enhanced disclosure requirements with regard to short-term borrowing (SEC 2010).

With the anonymized data available for this study, only a first glance at the subject but no in-depth analysis is feasible. The relevant parameter would be net outstanding volume after accounting netting, for which information on the accounting standard (and its interpretation) applied by each bank is missing. For IFRS, IAS 32 is the standard for netting financial instruments, which has not been subject to major changes but for which new application guidelines were issued in 2011. Until then (but even afterwards), the application of IAS 32 to CCP repo trading could have been subject to different interpretations. To see whether there is a reporting day-related trading pattern, we conduct a t-test mean comparison and a non-parametric median comparison (Kruskal-Wallis) of values on reporting and non-reporting days. Results (not shown) indicate that gross trading and outstanding volumes do not show a statistically significant end-of-quarter deviation at the aggregate level, while differences (in both directions) are significant for some market participants.

Some indirect evidence of reporting day-induced trading patterns might be deducted from repo rates. Should cash providers in repo markets be less willing to extend liquidity at quarter ends due to their own liquidity needs, the incentive to report higher liquidity buffers or to engage in window dressing by repaying debt, they are effectively limiting the possibility for borrowers to raise funds. Repo rates should then go up before reporting dates as supply contracts; this is something we do observe to some extent in the aggregate data. However, the difference between repo rates at quarter ends and average quarterly rates is not statistically significant at common confidence levels (Figure A7, panel B).