Repurchase agreements and the European sovereign debt crises: the role of European clearinghouses[☆☆☆]

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Abstract

This article investigates the European repo market and its role as an amplification channel for sovereign debt crises. We focus on the centrally cleared segment, representing the majority of European repos. A novel data set on repo and margin haircuts applied to sovereign bonds by central clearing counterparties (CCPs) is gathered, allowing us to assess the haircut methodologies used by the major European CCPs. We document that following increases in sovereign risk, haircuts set by major CCPs on peripheral sovereign bonds increased significantly. The procyclicality of haircuts and the concentration of bilateral repos raise concerns about the CCP-intermediated repo market as a source of systemic risk in the Eurozone. This is however mitigated by the countercyclical monetary policy of the European Central Bank (ECB).

Keywords: repo, haircut, CCP, systemic risk, sovereign debt crisis

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1. Introduction

Post-crisis interbank transactions in the Eurozone occur mainly via the secured market, where repurchase agreements (repos) account for an increasing share of liquidity in European financial institutions (Committee on the Global Financial System, 2013). This change in the financing patterns of European banks was caused by increased awareness of counterparty credit risk and the expansion of the liquidity operations of the European Central Bank (ECB). Ebner et al. (2016), Mancini et al. (2016), and Boissel et al. (2016) investigated repos transacted on the principal European anonymous electronic trading platforms (ETPs). Mancini et al. (2016), considering GC Pooling (GCP) repos from Eurex Repo, found that volumes, rates, and haircuts of this market segment were resilient during the crisis. On the contrary, Boissel et al. (2016), focusing on overnight repos collateralised by sovereign debt, find that this market became stressed in terms of rates and haircuts in the periphery of the Eurozone in 2011. Molteni (2015) shows that raises in haircuts on peripheral bonds have intensified tensions in the European sovereign debt market, tightening the link between sovereign weakness and banking fragility. The ECB's haircut policy is also key in understanding the behaviour of sovereign debt in the Eurozone in troubled times.

We create a novel dataset on haircuts applied by the main European central clearing counterparties (CCPs) to sovereign bonds. We provide an overview of the repo market and its evolution during the crisis, focusing on centrally cleared repos as they are a key source of financing for European banks. The empirical analysis yields the following findings:

- The majority of repos is centrally cleared.
- The repo market is concentrated in few market participants, CCPs, and underlying collateral assets.
- During the crisis, most CCPs raised their repo and margin haircuts on (peripheral) sovereign bonds of countries in financial distress. This empirical evidence raises con-

cerns about the European repo market as a potential transmission channel of systemic risk and as an amplifier of tensions in the sovereign debt markets.

As the haircuts set by these major CCPs may significantly affect the value of the security, we analyse CCP haircut policies during the crisis, emphasising the role of CCPs with regards to procyclicality and systemic risk in the sovereign debt market. Also, as outlined by Acharya and Steffen (2015), Coimbra (2014), Claeys (2014), and Drechsler et al. (2016), the ECB's monetary policy had a significant impact on the European sovereign debt markets and stakeholder strategies.

Some of our concerns are similar to those expressed when studying the US market. While the market structures in the EU and the US are strikingly different (Hördahl and King, 2008), repos largely financed the US shadow banking system and were targeted as a possible source of financial instability related to the procyclicality of leverage (Adrian and Shin, 2009, 2010), the maturity mismatch in investment banks' balance sheets (Brunnermeier, 2009), and the negative consequences of rises in haircuts on banking liquidity (Gorton and Metrick, 2010, 2012). Krishnamurthy et al. (2014) and Copeland et al. (2014) analyse, respectively, repo transactions of money market funds and security lenders and the tri-party repo market in the US, finding results contradicting the 'repo run' explanation for the liquidity crisis in 2007-2009. The latter report that in the tri-party market haircuts and the amount of funding were stable between 2008 and 2010, the former argues that the collapse in the asset-backed commercial paper (ABCP) market was the primary cause of the shadow banking system's breakdown. Martin et al. (2014) document that haircuts in the bilateral markets increased dramatically, whereas haircuts in the tri-party market barely changed. They argue that the tri-party repo market is much more vulnerable to runs due to its microstructure, as runs take place, when margins do not increase sufficiently to reassure the investor. They identify the early settlement of repos (unwind) as a destabilising feature of this market. Blundell-Wignall et al. (2014) show the raise in the gross credit exposure of derivatives and collateral

demanded in the US market during 2007-2008, illustrating the pressure on the liquidity of banks in respect to margin calls related to derivatives and repo positions.

The remainder of this article is organised as follows. Section 2 explains the different types of repos and introduces technical terminology. Section 3 describes the European repo market. Section 4 focuses on haircut methodologies and haircuts during the sovereign debt crisis. Section 5 explores the collateral policy of the ECB during the crisis. Finally, Section 6 concludes.

2. Repurchase agreements for European sovereign bonds

2.1. Concepts and definitions

A repurchase agreement is an agreement between two parties on the sale and subsequent repurchase of securities at an agreed price. The original seller is called cash borrower. The sell side are securities dealers, commercial banks, and leveraged investors such as hedge funds, using their securities as collateral for a secured cash loan at a fixed interest rate (repo rate), which is the difference between the repurchase price and the original sale price. The original buyer is the cash lender, typically central banks, commercial banks, investment funds, and money market funds. Central banks use repo to implement monetary policy operations, involving the provision of liquidity against a pre-defined range of collateral (European Central Bank, 2015).

The seller registers the transaction as a liability on its balance sheet and the buyer as an asset (reverse repo). We define repo transactions between two private financial institutions (i.e. interbank liquidity) as *private* repo and transactions conducted with the ECB (i.e. central bank liquidity) as *public* repo.

Unlike a secured loan, legal title to the securities passes from the seller to the buyer, who

may 're-use' the respective asset in another transaction with a third party. Due to differing title transfer arrangements and impending stricter regulatory rules for collateral re-use, collateral-chains will shorten (Singh, 2011, 2012).

The purpose of the collateral is to protect a lender against the risk of a borrower's default. The difference between the cash and the value of the collateral is called *haircut* or *initial margin*.

According to settlement type, repos can be divided into two categories (Adrian et al., 2014; Choudhry, 2010):

- Bilateral agreements are concluded between two counterparties on a 'delivery versus payment' basis, meaning that the transfer of the collateral to the cash lender occurs simultaneously with the transfer of the cash to the collateral provider. Bilateral agreements can be conducted on the private market or via a CCP.
- Tri-party repo agreements are based on the initial bilateral agreement and involve a third party, usually a custodian bank, acting as an intermediary. Tri-party providers offer the necessary back-office services to their clients, such as collateral management, risk management, settlement service, etc..

Repos occur with different maturities, but the majority of repos are short-term, overnight, or weekly (European Central Bank, 2012). Repos can be categorised as overnight repo, referring to a one-day maturity transaction, short-date repo, with a term of one month or shorter, and term repo, with a term of one year or longer. Other categories are forward repo, starting one or more months in the future, and open repo, which does not have a fixed maturity and can be terminated at any future date by either party.

Repos can also be distinguished by the underlying collateral asset: General Collateral (GC) repos are collateralised by a large basket of high quality and liquid securities that can be

equivalently pledged to the ECB, characterised by very similar repo rates. Special repos focus on a specific asset demanded as collateral. GC repos are cash-driven and motivated by the liquidity needs of the cash lender, while special repos are security-driven and may be part of short-selling strategies. Special repo rates are lower than GC repo rates. Credit repo is a repo using underlying collateral other than high quality securities, such as bonds issued by central governments in emerging markets.

There are several analogies between repo contracts in the 'securitised' banking system and deposits in the traditional banking system as highlighted by Gorton and Metrick (2012). Both provide liquidity to credit intermediaries and are funding sources for long-term activities. The haircut forces banks to keep a fraction of their assets in reserve when borrowing through repos, similar to a reserve requirement for traditional banks. Repo rates remunerate cash lenders similarly to the deposit rate for depositors. Finally, as the maturity transformation makes traditional banks subject to the risk of bank runs (Diamond and Dybvig, 1983), analogously the securitised banking system faces the risk of repo runs. Increases in haircuts reduce the amount of liquidity available to banks like a massive withdrawal of deposits, causing liquidity shortages which may force asset fire-sales.

2.2. Cleared repo

In a cleared repo, a CCP interposes itself between the cash lender and the cash borrower. The CCP guarantees that the trade will be delivered to both parties and assumes the counterparty risk (Gregory, 2014). To protect the CCP against participant default, each participant has to provide margin and contribute to the default fund. In contrast to bilateral repos, a CCP demands margin from both the cash lender and the cash borrower (Committee on Payment and Settlement Systems, 2010). We can distinguish between the security that the borrower provides to the lender in the repo (underlying security) and securities that the borrower and the lender can provide as margin to the CCP (margin collateral). Margin requirements can be met in cash or by posting securities. If the margin requirement is provided in securities,

the CCP will again apply a haircut.

The exact composition of the overall margin depends on the CCP, but generally comprises

- variation margin (VM) to cover daily portfolio variations;
- initial margin (IM) to cover potential losses (between the last VM payment and the final close-out of the defaulter's position) the CCP may face in case a member defaults. IM models have to meet established regulatory confidence levels;
- additional margin (add-on) demanded on portfolio level
  - when a concentration limit for a deposited security is breached or in case of wrong-way risk (negative correlation between issuer and provider of a security);
  - to cover currency risk, if the trading currency and the margin currency are not identical;
  - when participants have a lower credit standing or capital resources.

The IM amount is obtained from the haircut set by the CCP (see Eurex Clearing (2012)). Contrary to the bilateral haircut, IM is a percentage premium that is added to the market value of the asset (Committee on Payment and Settlement Systems, 2010).

2.3. Regulatory incentives

International repo markets are subject to a wide range of new regulatory measures and incentives, possibly resulting in fundamental changes in the use of repos and repo market structures.

At European level, a Financial Transaction Tax (FTT) is foreseen for financial transactions, including certain types of repos (European Commission, 2013b,a). Besides the fact that the FTT would only be applied by 11 member states (Gabor, 2016), the expected negative impacts for the repo markets include overall volume decline, vanishing of overnight repos, and

decrease of available liquidity (Comotto, 2013).

The Basel III Liquidity Coverage Ratio (LCR), which aims at promoting short-term resilience, has a direct impact on repos (Basel Committee on Banking Supervision, 2013a, 2014). If the market participant faces potential maturity mismatches in his cash flows for security financing transactions (SFT), such as repos, with a maturity of less than thirty days, he must cover this possible liquidity risk by holding high quality liquid assets (HQLAs). The LCR addresses cash in- and outflows over a period of 30 days with a roll off of repo transactions determined by asset quality. For short-term transactions, this may incentivise banks to use lower quality assets for central bank operations and HQLAs for private repos (Schmitz, 2013). Under the LCR, government bonds, which do not '*have a proven record as a reliable source of liquidity* [...] *during stressed market conditions*' (Basel Committee on Banking Supervision (2013a), p.13), are not considered as HQLAs. When the creditworthiness of a government erodes and haircuts on such debt increases, banks sell off these securities. This not only to avoid a cut of leverage and funding, but also to meet the new regulatory requirements, reinforcing flight-to-liquidity towards the bonds of the core and debt market fragmentation.

As for the Basel III leverage ratio (LR), the June 2013 proposal of Basel III (Basel Committee on Banking Supervision, 2013b) did not allow for netting of SFTs, whereas the revised Basel III LR framework (Basel Committee on Banking Supervision, 2014) allows for limited netting of repos with the same counterparty. In contrast, CCP cleared contracts can even be netted across different asset classes. If SFTs cannot be netted, the LR would constrain banks' leverage, which may lead to an increase in cleared repos. Altogether, the Basel III requirements may increase costs for repo trading and funding, besides resulting in an increase of HQL demand and possibly amplifying the feedback loop between the raise in haircuts and the fall in the value of the security collateral described by Brunnermeier and Pedersen (2009).

The Financial Stability Board (FSB) has focused on the implementation of policies associated to shadow banking (Financial Stability Board, 2012, 2013, 2014b), issuing recommendations regarding repos: collection of detailed data on repo exposures, implementation of rules to improve re-hypothecation, adaption of minimum regulatory standards for collateral evaluation, possible move of repos to CCPs, and the introduction of minimum regulatory haircuts to address the procyclicality of haircuts associated with repos (Financial Stability Board, 2012, 2013, 2014b,a). The first Quantitative Impact Study (QIS) on the procyclicality of haircuts (Financial Stability Board, 2014a) shows that haircuts for non-centrally cleared repos increased for all underlying securities during the crisis, except for government bonds. Consequently, regulators will implement minimum standards for non-centrally cleared repos with non-government collateral (Financial Stability Board, 2014b). This will increase funding costs for non-banks for all collateral, possibly leading to a reduction in trading activity in the private markets.

The systemic importance of CCPs, clearing banks, and dealer banks must be considered in case such an institution fails and needs to be resolved or recovered. Except for the UK, current regulation does not cover the resolution of CCPs (Armakolla and Laurent, 2017). Thus, regulators must carefully consider the consequences of a possible boost in repo clearing.

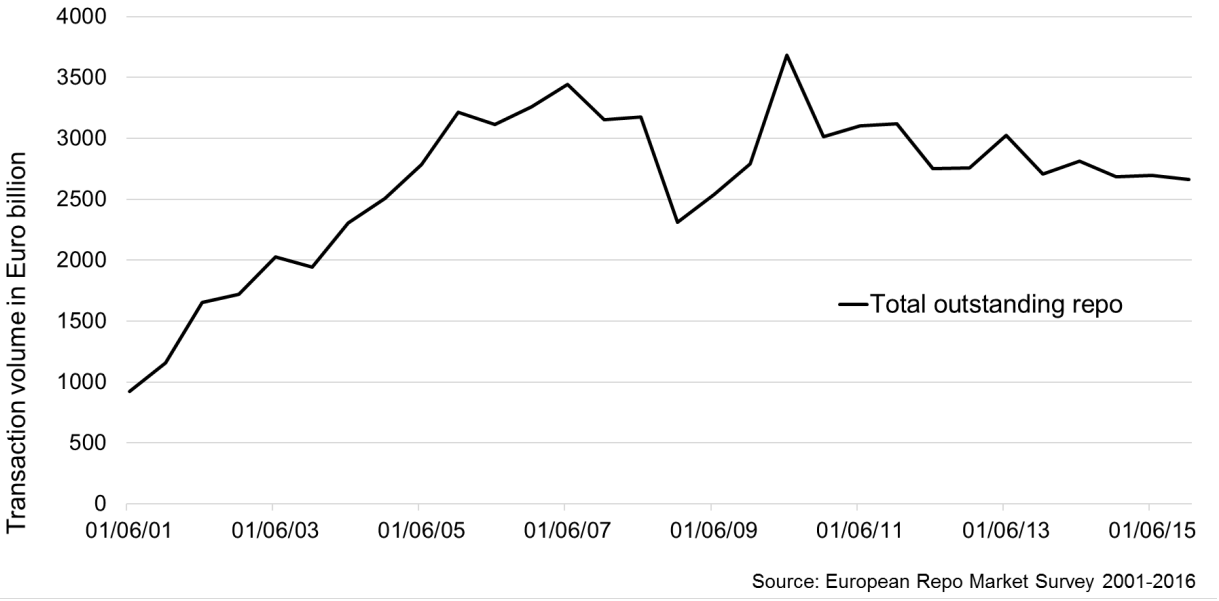
3. The European repo market

Due to the lack of comprehensive and standardised information, we rely on the following public data sources:

- Bankscope: database on banks' balance sheets at yearly and quarterly frequency;
- European Repo Market Survey (ERMS): semi-annual survey conducted by the International Capital Market Association (ICMA) since 2001;
- Euro Money Market Survey (EMMS): yearly survey published by the ECB since 2002.

The significant expansion of the European repo market is documented in Figure 1, showing the amount of repos in the balance sheet liabilities of European banks.

Figure 1: The European repo market



Repo volumes tripled between June 2001 and December 2007 from 0.92€ trillions to 3.44€ trillions. In December 2009, volumes contracted to 2.79€ trillions in December 2009, recovering rapidly in June 2010, reaching 3.70€ trillions. This estimate is close to the about 4€ trillion of the outstanding repo business of the US primary dealers in 2009 (Acharya and Öncü, 2013).

Repos have become a key source of liquidity for European financial institutions, as shown in Table 1.

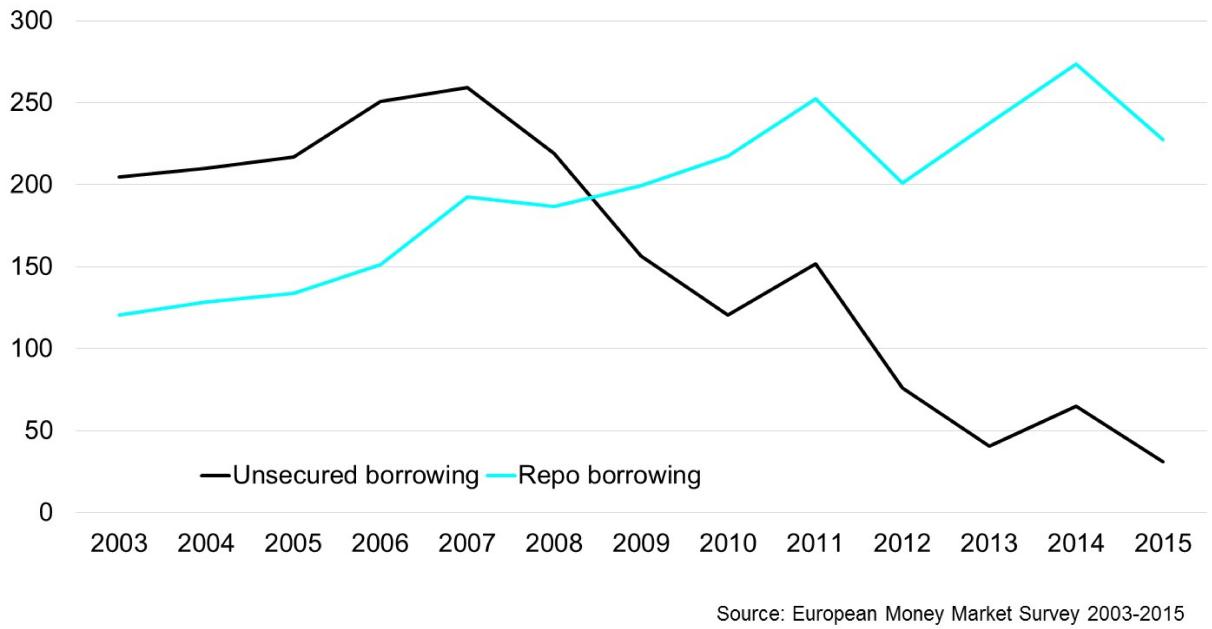
Table 1: Funding structure of European G-SIB banks in 2010 (in percentage of total liabilities)

Bank name	Customer deposits	Bonds	Repos	Interbank deposits
BNP Paribas	26.62 %	6.19 %	10.48 %	7.07 %
Barclays Bank Plc	23.41 %	9.89 %	13.26 %	5.89 %
Banco Santander	45.04 %	16.92 %	9.60 %	4.69 %
Société Générale	24.47 %	8.74 %	9.58 %	7.62 %
UBS AG	24.13 %	10.04 %	12.52 %	2.13 %

Source: Bankscope and Molteni (2015)

Repo data reported by Bankscope includes repos transacted with the ECB, thus we analyse the data in 2010 before the two large-scale LTROs in December 2011 and February 2012. As shown in Table 1, European G-SIB banks hold a considerable high fraction of repos in their balance sheet (approximatively 10 % or more of their liabilities) and for most of the European banks secured funding accounts for a larger share than unsecured funding.

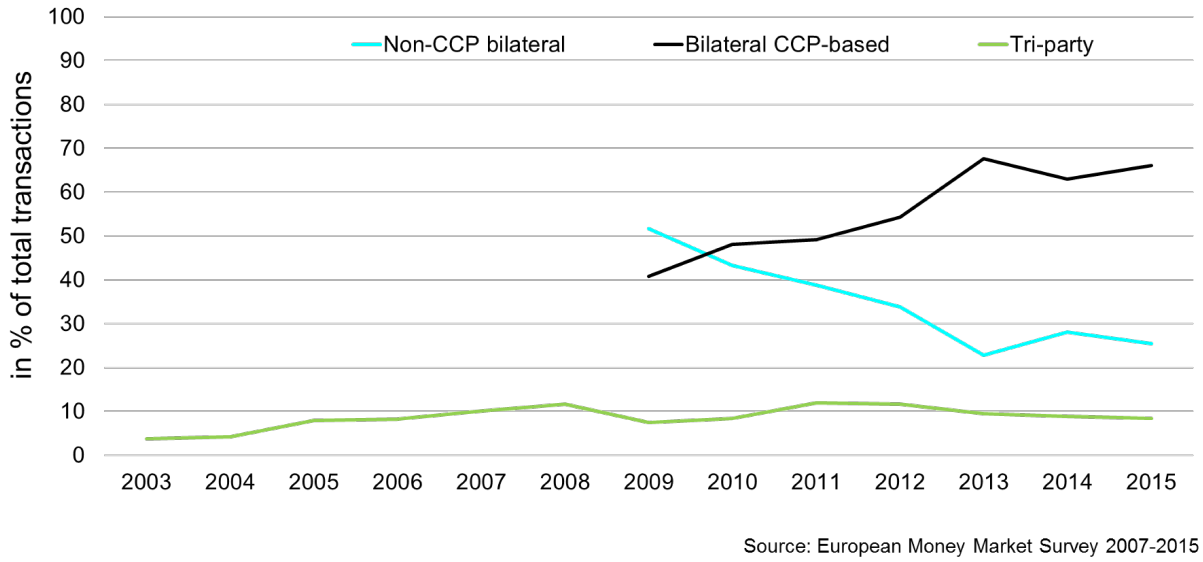
Figure 2: Cumulative quarterly turnover in unsecured cash lending and borrowing (index: cash lending volume in 2003 = 100)



The EMMS (European Central Bank, 2012) reports that the unsecured market contracted steadily from 2008 to 2012, as shown in Figure 2. This resulted in a switch from unsecured

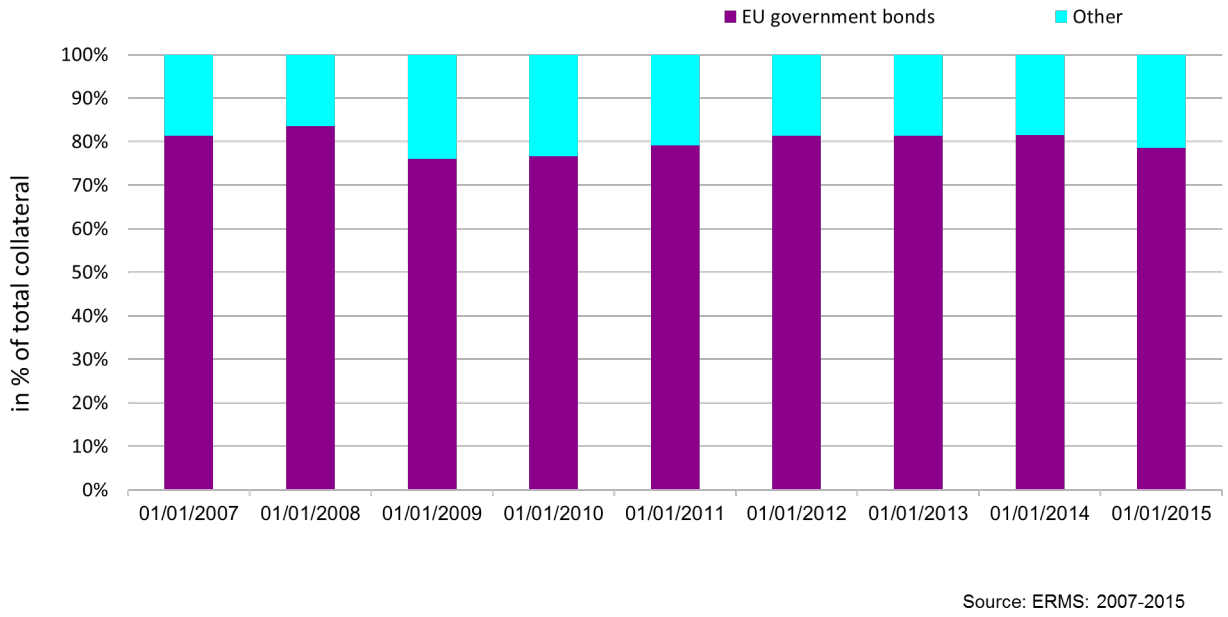
to secured lending. The diverging evolution of the two markets follows the decoupling of interest rates between the unsecured and the secured markets during the crisis (Heider and Hoerova, 2009). The EMMS also reports that the largest five banks accounted for 40 % and the top ten banks for 62 % of the total turnover for repo transactions, respectively, suggesting that European repos are highly concentrated between few financial institutions.

Figure 3: Composition of the European repo market



Approximatively 70 % of European bilateral repos are cleared by CCPs, following an increasing trend since 2009 (see Figure 3). Trilateral repos account for approximatively 10 %, contrasting the approximately 70 % of repos managed by a tri-party provider in the US (Copeland et al., 2012).

Figure 4: Percentage of EU government bond collateral from 2007-2015



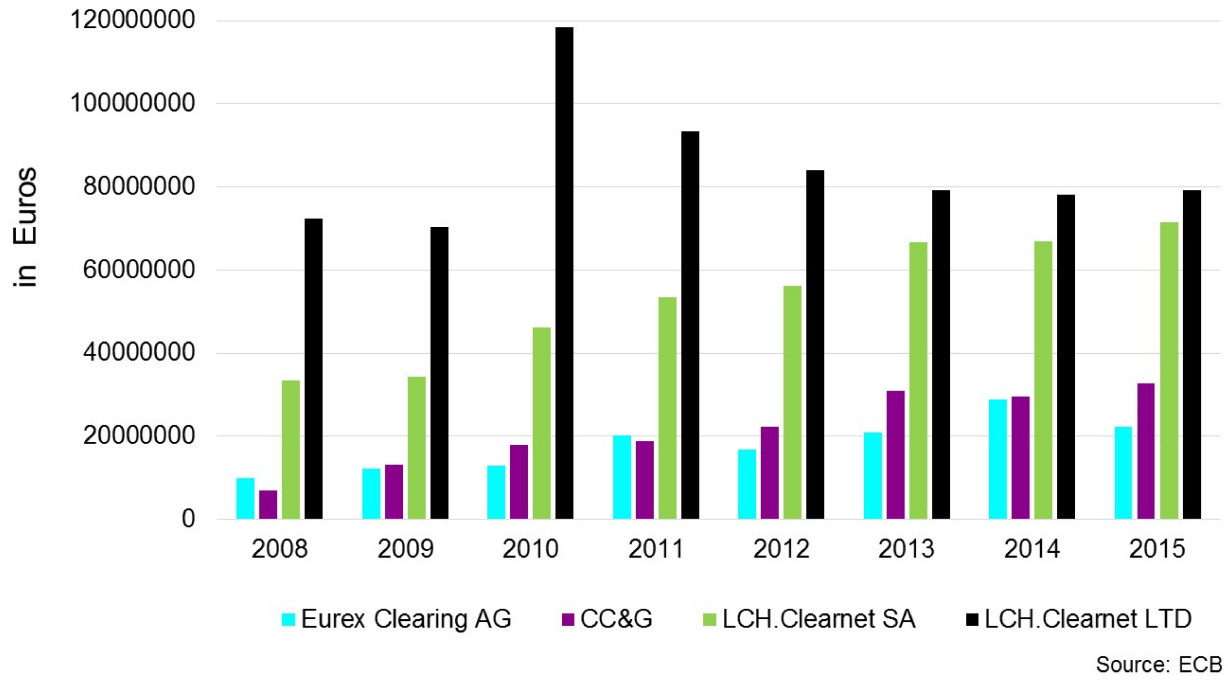
A further structural characteristic of the European repo market to consider, is the type of collateral used by market participants as repo underlying. Government bonds are the main type of repo underlying collateral used in the European market, representing approximately between 76 % and 84 % for the period 2007 to 2015. The proportion of government bonds fell below 80 % following the onset of the worldwide crisis, its further evolution then dampened by the European sovereign debt crisis. The percentage of government bonds within the pool of all EU-originated collateral as reported in the ERMS from 2007 to 2015 is shown in Figure 4. The values are in percentage of total repo activity, according to collateral issues in the relevant country.

Interestingly, the use of government securities as collateral in the European private repo market seems to reflect their credit risk and liquidity. For instance, according to the ERMS, the share of Italian government bonds within the pool of collateral fell from 11.8 % to 6.4 % between December 2008 and December 2001, respectively, recovering to 9.2 % in December 2013, when tensions in the Italian debt market alleviated and both the yields and the haircuts

on Italian bonds reduced.

Finally, the Eurozone repo market is concentrated in only a few clearing houses: LCH.Clearnet SA (Paris), LCH.Clearnet LTD (London), Eurex Clearing AG (Frankfurt), and and Cassa di Compensazione e Garanzia SpA (CC&G) (Rome). Figure 5 shows the volume of cleared repos for these main CCPs.

Figure 5: Volume of cleared repos per CCP from 2008-2015



To sum up, we observe a rapid expansion of European repos in the last decade, as well as a radical transformation of the interbank market during the crisis associated with an increase of repos cleared via CCPs.

Our work complements the FSB's study (Financial Stability Board, 2014a) regarding non-centrally cleared SFTs, according to which the contraction in the repo market during the crisis was substantial in both absolute and relative terms, especially for non-banks. The decline in the share of non-CCP based repos in the European repo market, see Figure 3,

seems to confirm these findings for the European jurisdiction. Financial Stability Board (2014a) finds that haircut levels and dispersion increased dramatically for all collateral types except government securities, while in the next Section we show that haircuts on government bonds issued by the peripheral EU countries sharply augmented during the crisis.

4. CCPs and repo haircuts

4.1. Eligibility criteria and repo haircut methodologies

Haircut calculation methodologies are based on VaR and liquidity measures, the credit rating of the collateral or the issuer, credit spreads, the maturity of the collateral, and benchmark haircuts set by central banks (European Parliament, 2013; Committee on the Global Financial System, 2013). To be compliant with EMIR, CCP haircuts should be established taking into account criteria related to the quality of the asset (asset type, credit risk level, maturity, historical and hypothetical future price volatility, market liquidity, FX risk), wrong-way risk, and limit procyclicality (European Central Bank, 2013).

Eurex Repo offers trading, clearing and settlement services within the GC and special repo segment. Post-trade services, such as margining, are performed by Eurex Clearing AG. We study haircuts applied to sovereign debt instruments in the GC Pooling (GCP) ECB basket, which are based on the ECB's haircuts (see Table 2). The collateral framework of the GCP ECB basket is based on the collateral framework of the ECB's open-market operations.

Table 2: ECB haircuts for 10-year government bonds

01.02.2009	01.01.2011	01.10.2013	Rating
4 %	4 %	3 %	AAA to A-
4 %	9 %	11.5 %	BBB+ to BB-

Source: European Central Bank

In 2012, the basket comprised around 7500 securities from the following eligible issuer countries: Austria, Belgium, Finland, France, Germany, Luxembourg, Netherlands, Slovakia, and Slovenia.

Given the rare revision of ECB haircuts and the independence of daily or even monthly changes in market conditions (Nyborg, 2017), Eurex Clearing AG conducts its own risk assessment, often resulting in higher haircuts than those of the ECB (Eurex Clearing, 2012).

Securities that do not have at least a credit rating of 'A-' from Standard & Poor's, Fitch Ratings or an 'A3' from Moody's are excluded from the basket. On 27^{th} January 2012, Italian government bonds were excluded from the GCP ECB basket as Italy was downgraded (Eurex Repo, 2012). The cash provider can re-use the received collateral for refinancing within the ECB framework, the Eurex GCP market, and as margin.

The London Stock Exchange Group (LSEG) comprises LCH.Clearnet LTD, LCH.Clearnet SA, and CC&G. We rely on general documentation and information from the risk notices on the website of the LCH.Clearnet Group. LCH.Clearnet SA and CC&G use the same methodology for setting repo haircuts.

For LCH.Clearnet LTD's RepoClear classical repos, the following government bonds are eligible: Austrian, Belgian, Dutch, German, Irish, Finnish, Portuguese, Slovakian, Slovenian, Spanish, and UK. For a government bond, a spread of 450 basis points over a 10-year AAA benchmark (e.g. German government bond) serves as an indicative level at which haircuts may be reviewed (LCH.Clearnet Group LTD, 2014). If the spread exceeds 450 basis points, a haircut of 15 % is applied (LCH.Clearnet Group LTD, 2010). CDS prices and market implied rating data are used to assess whether additional margin is required (LCH.Clearnet Group LTD, 2014).

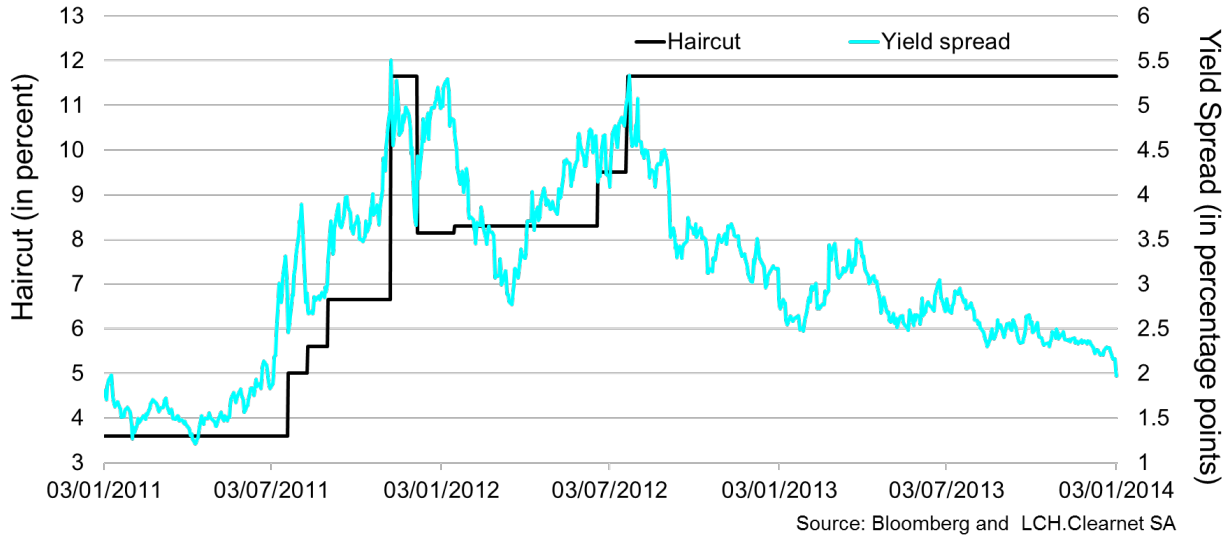
LCH.Clearnet SA accepts French, Italian, and Spanish government debt for classical repos, whereas CC&G only clears Italian government debt. CC&G and LCH.Clearnet SA monitor sovereign risk via a market data based model including several indicators for sovereign risk: CDS spreads, sovereign bond spreads, default probabilities, and credit ratings (Cassa di Compensazione e Garanzia S.p.A., 2012).

4.2. Haircut levels during the crisis

Now we assess the evolution of CCP haircuts applied to government bonds with 10-year maturity during the European sovereign debt crises. Government bonds are categorised according to their haircut level during the crisis: bonds issued by European core countries (France and Germany) with rather stable haircuts, Italian and Spanish bonds with considerable haircut increases, and Irish and Portuguese bonds with extremely high levels of haircuts.

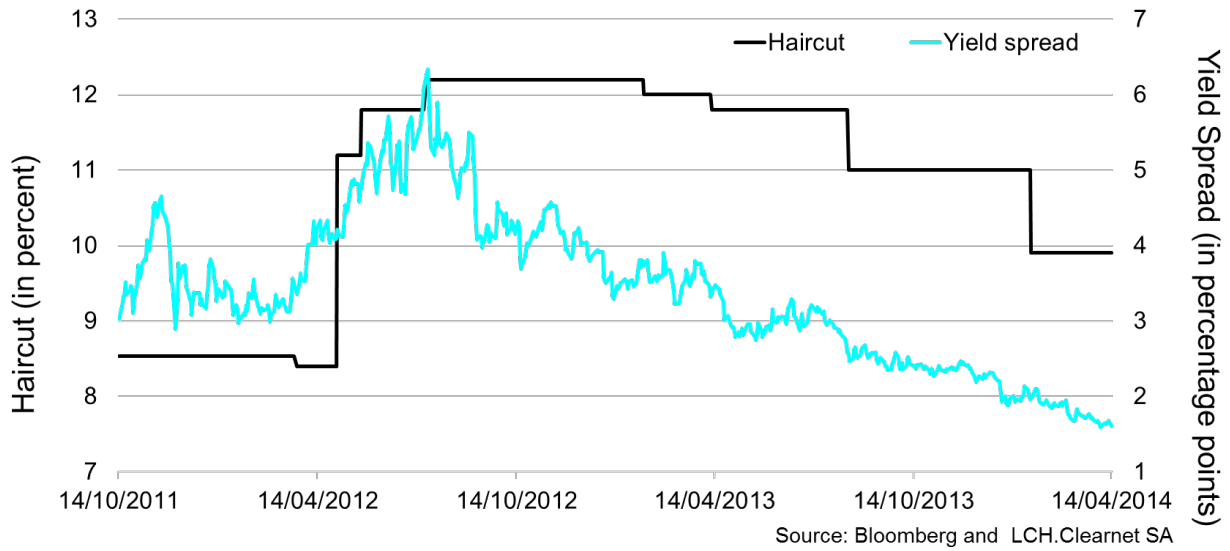
Haircuts on Italian debt were increased several times by LCH.Clearnet SA and CC&G. Figure 6 shows the jump of the haircut applied by both CCPs from 6.65 % to 11.65 % on 9^{th} November 2011 during the most acute phase on the Italian debt market. Following the reduction in the bond yields, the haircut decreased to 8.3 % between January and June 2012, rising again to 11.65 % on 23^{rd} July 2012.

Figure 6: Haircut and yield spread of 10-year-Italian on 10-year-German sovereign bond



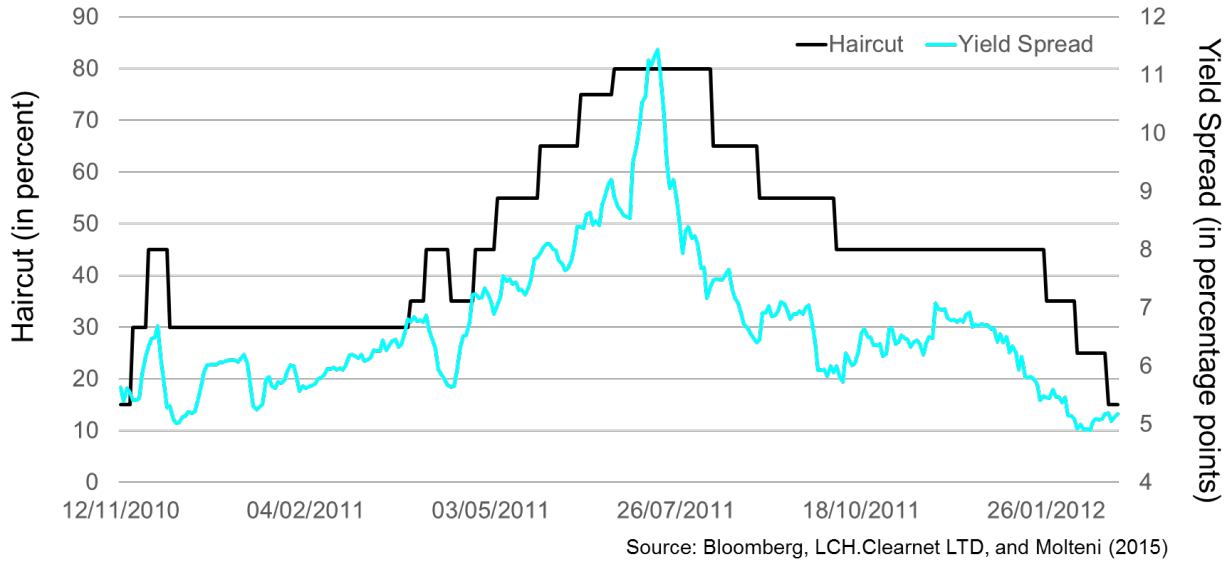
The volume of Italian government repos intermediated by the two CCPs via the interoperability agreement highly increased throughout 2012 and 2013 (Banca d'Italia, 2013a). This may also explain why the haircut on Italian government bonds was maintained at such a high level (Banca d'Italia, 2013b). As Italian debt was downgraded to 'BBB+' on 13^{th} January, Italian bonds were excluded from the Eurex GCP ECB basket (Eurex Repo, 2012). A collateral framework that is based on central bank haircuts, does not function in the same way as a collateral framework, in which haircuts are increased or decreased if necessary. If central bank haircuts are used, the range of eligible assets is narrowed down by the CCP, when the rating of a bond falls below a certain threshold.

Figure 7: Haircut and yield spread of 10-year-Spanish on 10-year-German sovereign bond



As shown in Figure 7, LCH.Clearnet SA also increased the haircut on Spanish government bonds in 2012 from 8.53 % in January to 12.2 % in July, and went down to 8.5 % in August 2014.

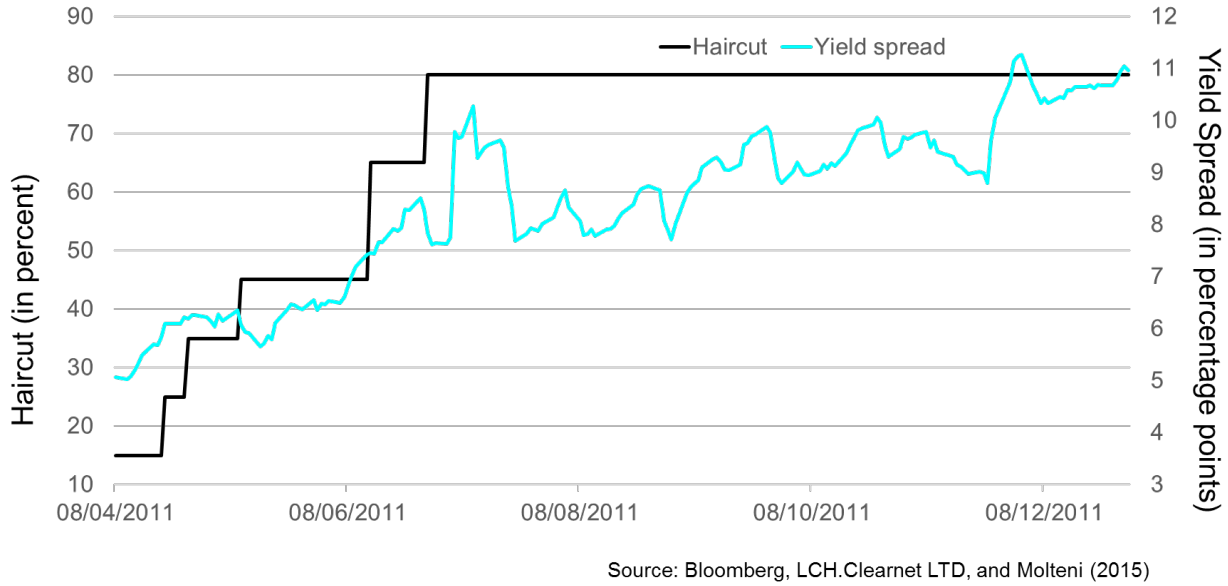
Figure 8: Haircut and yield spread of 10-year-Irish on 10-year-German sovereign bond



A more striking sequence of haircuts increases was observed for Irish bonds as shown in Figure 8. For the Irish government bonds, the dynamic of the haircut tracks that of the bond spreads closely. The haircut on Irish bonds increased from 15 % to 80 % between November

2010 and June 2011, falling back to 15 % in February 2012. On 1^{st} April 2011, LCH.Clearnet LTD increased the haircut to 45 % from an initial 35 % and decreased it again to 35 % on 13^{th} April 2011, suggesting that the haircut was set as a function of the spread. As stated in the member notices, LCH.Clearnet LTD, in each case, increased the haircut as a response to the yield spread of the 10 year-Irish bond on an 'AAA'-rated benchmark.

Figure 9: Haircut and yield spread of 10-year-Portuguese on 10-year-German sovereign bond



Source: Bloomberg, LCH.Clearnet LTD, and Molteni (2015)

In Figure 9, a similar evolution can be observed for the haircuts on Portuguese bonds which steadily augmented between April 2011 and June 2011, passing from 15 % to 80 %. These increases were associated with a widening of the yield spread, while the double downgrade in March 2011 from an initial 'A-' to 'BBB-' did not have an impact. Eurex Repo excluded Portuguese bonds from all its' repo markets in January 2012 (Eurex Repo, 2012), corresponding to a haircut of 100 %. The increase of CCP haircuts on Irish and Portuguese government bonds in 2010 and especially in 2011 caused CCP repo activity to almost cease for both securities in 2011 (Boissel et al., 2016; Morgan Stanley Research, 2011).

The haircut increases on peripheral bonds have two important economic consequences. First, they shrink the amount of funding that financial institutions can obtain. For instance, if be-

fore the crisis a bank could borrow 85 € by pledging a portfolio of Irish and Portuguese bonds which was worth 100 €, in the midst of the crisis with the same value of collateral securities they could borrow only 20 €. Second, the haircut increases cut the maximum leverage of financial institutions.

As banks fund their bond purchases mainly via repos, the haircut also determines the maximum possible leverage: before the crisis in order to purchase Irish and Portuguese bonds which were worth 100 €, banks could borrow up to 85 € by pledging these securities in repos cleared by LCH.Clearnet LTD with a haircut of 15 %; thus the leverage was 100 / 15 = 6.6. When the haircuts spiked to 80 %, the leverage fell to only 1.25.

The prolonged pre-crisis periods of low yields and risk premia on peripheral bonds along with the low levels of haircuts encouraged banks to expand their leverage, by pledging these securities in the repo market. The surge of sovereign risk led to an increase in yields and haircuts, exacerbating deleveraging incentives during the crisis. The procyclicality of haircuts in the private markets reinforces the procyclicality of leverage and consequently of the asset prices (Adrian and Shin, 2009).[1]

Structural characteristics of the European repo market, such as the required provision of margin by both the cash lender and the cash borrower for CCP based repos, reinforce the 'margin spiral' mechanism (Brunnermeier and Pedersen, 2009). A raise in the margin haircut makes the posted security less liquid and increases funding costs for the margin requirement for both parties.

[1] As shown by Koulischer and Struyven (2014), the ability of a central bank to alleviate such procyclical effects in the private markets by relaxing its collateral policy is crucial to avoid credit crunches, transferring additional credit risk and possibly imposing costs to the central bank.

Figure 10: Minimum haircuts for margin collateral by Eurex Clearing AG

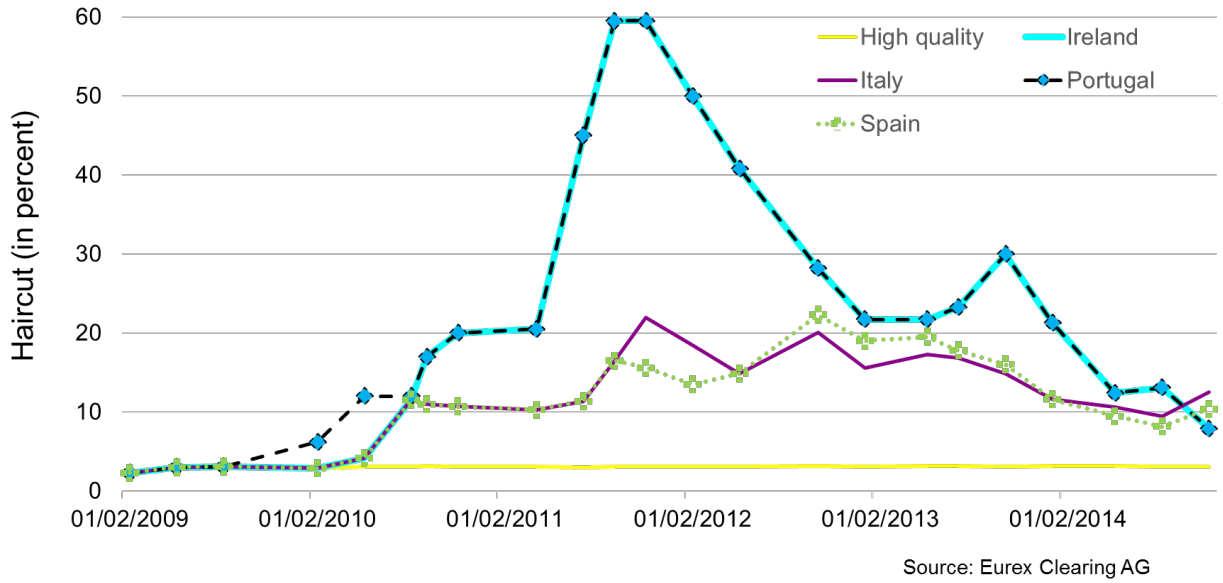
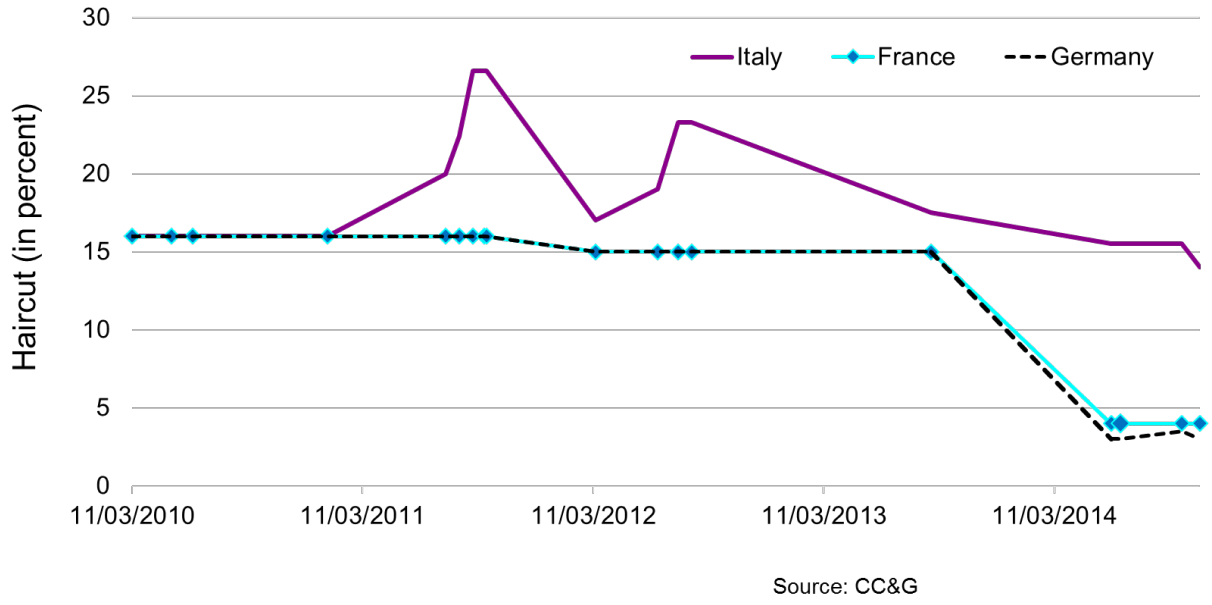


Figure 10 shows the minimum haircuts applied by Eurex Clearing AG to government bonds posted as margin collateral. Until the beginning of 2010, Irish, Italian, Portuguese, and Spanish government bonds were regarded as high quality collateral and received low margin haircuts (approximatively 3 %). Throughout 2010 and 2011, the haircuts on these securities were notably increased.

In analogy to the rises in repo haircuts, the margin haircuts for Italian and Spanish government bonds rose considerably, whereas the margin haircuts for Portuguese and Irish bonds reached extremely high levels. In November 2011, Eurex Clearing AG's margin haircuts reached their peak with at least 22 % for Italian government bonds, and in October 2012 the Spanish government bonds were subject to a margin haircut of 22.3 %. From late September 2011 to late February 2012, Eurex Clearing AG applied a margin haircut of 59.5 % to Irish and Portuguese government bonds. In contrast, the margin haircut for high quality government bonds, such as French and German, remained rather stable at approximately 3 % throughout the crisis.

As shown in Figure 11, the margin haircuts applied by CC&G to Italian government bonds with a 10-year maturity never fell below 16 % between March 2010 to August 2013, reaching its peak in September 2011 at 26.6 %. In contrast to Eurex Clearing AG, the margin haircuts for French and German bonds remained rather high at around 15 % throughout the crisis.

Figure 11: Haircuts for margin collateral for 10-year government bonds by CC&G



Similar to developments in haircut increases for repos, margin haircuts may be a further factor contributing to the magnification of downward margin spirals.

As government debt is principally used by the largest European banks to obtain more funding through repos cleared by few CCPs and possibly to cover margin requirements, the possibility of synchronised actions must be considered as clearing members are informed in advance of upcoming haircut changes either via internal messages or circulars. When a CCP raises the repo haircut and margin haircut on sovereign debt, banks will tend to react synchronically with a stronger impact on the price of the bond.

5. The collateral policy of the ECB

During the crisis, the ECB put in place the following non-standard measures to alleviate stress in the impaired interbank markets:

- Introduction of fixed-rate full allotment tender procedures in the refinancing operations;
- Expansion of the list of eligible collateral;
- Long-Term Refinancing Operations (LTROs) with maturity of up to three years;
- Emergency Liquidity Assistance (ELA).

These policies succeeded as banks could entirely meet their liquidity needs by borrowing cheap funding from the ECB or National Central Banks in case of ELA (see Lenza et al. (2010) and Darracq-Paries and De Santis (2015)). By pledging assets, which were not accepted in private repos any more, banks could relax their liquidity and collateral constraints. Moreover, Mayordomo et al. (2015) document a significant decrease of fragmentation in the European interbank market after the Securities Market Programme and the 3-years LTROs.

These measures indirectly mitigated the pressure on sovereign bonds as banks in the periphery could finance governments by borrowing long-term loans from the ECB through 3-year LTROs in carry trade operations (Acharya and Steffen, 2015; Coimbra, 2014). More than 70 % of the liquidity injected by the ECB in the banking system has been absorbed by banks in Spain, Italy, Ireland, Greece, and Portugal (Claeys, 2014). Using data on collateral tendered to the ECB during the period 2007-2011, Drechsler et al. (2016) find that European banks increased their holdings of lower quality government bonds by about 45 % of the amount of increase in their pledging of lower quality government bonds to the ECB.

Did the ECB's collateral policy mitigate the tensions on the peripheral sovereign debt markets, caused by raises in repo haircuts and the 'flight-to-liquidity' from high-haircut to low-haircut bonds? Government securities represent the largest share of eligible collateral for the

Eurosystem, accounting for around one half of the total[2]. Nevertheless, pre-crisis less than 20 % of the effective posted collateral was composed of government securities and only 4 % of the 4.1 € trillion stock of sovereign bonds was employed as collateral for the Eurosystem credit operations, leaving the remainder to be used in the private repo market (Cheun et al., 2009). Cassola et al. (2013) find that banks started to substitute illiquid assets (uncovered bank bonds and asset-backed securities (ABS)) for liquid securities (government securities) as collateral for Eurosystem refinancing operations before the crisis. This trend intensified during the crisis when illiquid collateral was migrated from the private markets towards the ECB following the extension of eligible collateral, giving banks the possibility to pledge low-rated securities (European Central Bank, 2010). Cassola and Koulischer (2014) show that between January 2009 and September 2011 government bonds accounted for only 14 % of total pledged assets compared with 34 % of ABS, which in 2008 were less than 10 % of total securities posted in main refinancing operations.

Banks preferred posting government bonds as collateral in private repos and private assets for ECB refinancing operations as repo rates were substantially lower than the main refinancing operation (MRO) rate and some securities were only accepted by the ECB. Mancini et al. (2016) show that rates on interbank transactions performed on an anonymous ETP operated by Eurex Repo fell to the level of the ECB deposit rate during the crisis after the introduction of the auctions with full allotment, suggesting the CCP-based interbank repos were perceived as a safe harbour to hoard liquidity in times of stress. Similarly, Boissel et al. (2016) find that repo rates in BrokerTec and MTS platforms drastically reduced, but they also note that the rates of repos in peripheral countries reached the level of the MRO rate between June 2011 and December 2012, being more sensitive to the sovereign risk.

[2]See the collateral data of the Eurosystem, available at `https://www.ecb.europa.eu/paym/coll/charts/html/index.en.html`.

The stance of the ECB's collateral and haircut policy during the crisis is ambiguous. On the one hand, it expanded the range of eligible collateral and suspended the minimum rating threshold for Greek, Irish, and Portuguese bonds. On the other hand, it increased the haircuts on sovereign bonds that were downgraded from 'A-' to 'BBB+' as measure of risk management (see Table 2). Therefore, even though the ECB haircuts on peripheral bonds were lower than those applied in the money market, their increases widened the liquidity wedge between low-rated and high-rated bonds.

Central bank haircuts are an important monetary policy instrument impacting security yields and use of collateral securities. Monetary policy measures using haircut reductions, such as the US Term Asset-Backed Securities Loan Facility (TALF) program described by Ashcraft et al. (2010), can bring down the required returns of eligible collateral. In their model, the reduction of the policy rate decreases the yields of low-haircut assets, but may increase those of high-haircut assets, due to the raise in the shadow cost of capital-constraint agents. As explained by Corradin and Rodriguez-Moreno (2014), different ECB haircuts can result in a large yield spread between USD- and Euro-denominated bonds, possibly generating a significant monetary funding premium. As documented by Cassola and Koulischer (2014), a central bank's collateral and haircut policy can also impact how banks use collateral securities and that this impact varies according to security and bank characteristics. The study demonstrates that a 1 % increase in the haircut on low-rated government bonds would lead to a fall in their share in the pool of collateral by 0.44 % in absolute terms for high yield countries. This substitution effect following margin increases is observed in other classes of assets. Committee on the Global Financial System and the Markets Committee (2015) shows the increase in haircuts on some additional credit claims in 2012 significantly reduced their share over total credit claims posted as collateral, suggesting a strong sensitivity of securities collateral to haircuts.

During the crisis the ECB acted as lender of last resort in accordance with Bagehot prescriptions (Bagehot, 1873). First, it announced its readiness to lend without limits through refinancing operations with full allotment. Second, it lent at a higher rate than the market. Third, it lent against good collateral or it set higher haircuts on riskier securities to protect against insolvency risk. In doing so, the ECB relaxed the liquidity constraints on European banks, reducing procyclicality and market fragmentation. However, the raise in ECB haircuts on low-rated bonds, although lower than those set by CCPs, may have adversely affected their liquidity and required returns.

6. Conclusion

Policymakers and regulators are aware of the implications of the different repo market segments for systemic risk (European Securities and Markets Authority, 2016; Constancio, 2016). The ECB recognises that '*risk concentration within CCPs will grow, both nationally and internationally. CCPs are increasingly turning into institutions of unprecedented systemic importance*' (Coeuré, 2014). The European Parliament worries about the procyclical effects caused by changes in haircuts and proposes the introduction of minimum standards for the calculation of haircuts in order to stabilise them across the cycle (European Parliament, 2013). Financial Stability Board (2014b) recommends imposing a numerical haircut floor applied to non-centrally cleared SFTs, excluding transactions backed by government securities and centrally-cleared SFTs and financing provided to banks and broker-dealers subject to adequate capital and liquidity regulation on a consolidated basis.

Our analysis has highlighted new findings on the cleared repo market, which have several repercussions for financial stability deserving the attention of policymakers. Secured transactions are concentrated in few CCPs, which play a determinant role in the functioning of the interbank markets. Also, in the EU, the size of the CCP-cleared repo market has become much larger than that of unsecured and non-CCP cleared repo markets. However, little in-

formation is available on how CCPs set haircuts and how they acted in time of crisis. This is a key challenge for macroprudential authorities and financial regulators.

As illustrated by the Eurozone debt crisis, sovereign bonds are not immune to asset price shocks and liquidity shocks. The main European CCPs increased the haircuts on peripheral bonds in response to the surge of perceived sovereign risk. Due to the extensive use of sovereign bonds as collateral, stress in the European repo market jeopardises financial stability, because it creates an additional channel which ties the bank-sovereign nexus (Molteni, 2015). Peripheral banks augmented their exposure on domestic sovereign bonds after the onset of the global financial crisis and increasingly pledged these assets in the interbank market (Gennaioli et al., 2014), since the unsecured market shrank. However, the raises in CCP haircuts on government bonds reduced the funding liquidity of banks (Miglietta et al., 2015). This was in part offset by the unconventional policy of the ECB, which lent at lower haircuts than those applied by the CCPs, but at a higher rate and with differentiated haircuts for safe and risky bonds which may have had a substitution effect.

When analysing the effects of CCP haircut policies on the financial markets, it should be considered that CCP haircuts and margin requirements serve to protect the CCP. Although CCPs have public utility-like functions, they remain private sector entities. Thus, central bankers, regulatory authorities, CCPs, and other involved stakeholders should consider the introduction of approaches that allow to maintain CCP haircuts at predictable levels, limit procyclicality, and create a safe haven for government bonds, preserving the function of repo haircuts and margins to protect the CCP from price changes in collateral assets and member defaults. Nevertheless, the documented increases in haircuts create negative externalities and destabilising effects that regulators should take into account.

Reducing the procyclicality of repo haircuts would certainly disconnect this link between

sovereign weakness and banks' fragility. In particular, the crisis has shown the lack not only of a safe asset (see Corsetti et al. (2015)) but also of a liquid asset that can be generally used by banks as collateral in the repo market greasing the functioning of the interbank market, especially in times of crisis avoiding the frictions emerged because of the increases in haircuts, the fragmentation of the interbank market, and the flight-to-liquidity towards core bonds.

During a crisis, the stabilising effect of CCPs on repo markets depends on the smooth functioning of the link to monetary policy (Boissel et al., 2016). In the context of cleared repos and the effects of CCP haircut and margin policies on financial stability, there are two considerations to be taken into account: first, it should be considered that haircuts and margins serve to protect CCPs. Second, from a systemic point of view, the effects of sharp increases in haircuts and margins may lead to tensions in other parts of the financial system. In this spirit, a number of regulatory and supervision related issues should be investigated:

- Creation of countercyclical capital standards: in analogy to the countercyclical capital buffers of the Basel III framework, CCPs may consider introducing countercyclical capital standards as part of their risk management framework to avoid haircuts increases above a certain threshold. This would however increase costs to users during calm periods.

- System-wide monitoring: policymakers and supervisory authorities at European and national level might assess the systemic impact of simultaneous increases in haircuts and margins on system-wide procyclicality and funding capacities of clearing members in a CCP stress-testing framework.

- Monitoring of margin add-ons: CCP margins consist of several add-ons that are 'added' to the margin on portfolio level. In times of volatile markets, besides increasing haircuts and margins, CCPs may also need to increase the margin add-ons, possibly exacerbating procyclicality.

- Collateral swap with the ECB: in case of high volatility in the sovereign debt market, CCPs could exchange risky bonds against safe bonds with the ECB paying a fee (collateral swap).

- Insurance-like mechanisms: market participants and CCPs might use insurance-like mechanisms to protect themselves from increases in haircuts in times of stressed markets.

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