Repurchase agreements and systemic risk in the European sovereign debt crises: the role of European clearing houses

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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 transactions cleared via central clearing counterparties (CCPs), which account for the bulk of the repo market in the Eurozone. In particular, we collect novel data on repo haircuts applied on sovereign bonds and assess the methodologies used by CCPs for margining. We find that haircuts on peripheral sovereign bonds substantially increased in response to the rise in sovereign risk. Moreover, we document that the volume of the European repo market is strongly concentrated between few large financial institutions and few clearing houses. The procyclicality of haircuts and the concentration of secured transactions raise concerns about the CCP-intermediated repo market as a source of systemic risk in the Euro area.

Keywords: repo, haircut, central clearing counterparty, systemic risk, sovereign debt crises

Résumé

Cet article analyse le marché européen des pensions livrées et son rôle comme canal d’amplification des crises de la dette souveraine. Nous nous concentrons sur les transactions compensées par des contreparties centrales de compensation (CCPs) qui représentent la plus grande part du marché de la pension livrée. Nous présenterons un nouvel ensemble de données sur les taux de décote (haircut) appliqués aux obligations d’Etat par les CCPs. Nous constatons que les taux de décote sur les obligations d’Etat des pays périphériques ont considérablement augmenté en réaction à la hausse du risque souverain. Par ailleurs, nous montrons que le marché européen de la pension livrée est très concentré entre quelques institutions financières et chambres de compensation. Enfin, la procyclicité des taux de décote et la concentration des transactions sécurisées indiquent que le marché de la pension livrée éprouverait être une source de risque systémique dans la zone Euro.

Mots clés: pension livrée, taux de décote, chambre de compensation, risque systémique, crise de la dette souveraine

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EXECUTIVE SUMMARY

Since the global financial crisis, interbank transactions occur mainly via the secured market rather than the unsecured market in the Euro area, representing an increasingly important channel for banking liquidity. We investigate the European repo market which remains relatively unexplored, although its size is comparable to that of the US repo market which received much more attention as factor of financial instability during the liquidity crisis in 2007-2009. The empirical investigation sheds more light on this market and highlights the following characteristics which are a potential source for the systemic risk in the Euro area.

The European repo market is highly concentrated:

(i) Repo transactions are concluded between few large banks.
(ii) They are mainly bilateral arrangements cleared via few central clearing counterparties (CCPs).
(iii) Government bonds are the prime collateral for these transactions.

We investigate the existence of different calculation methodologies for repo and margin haircuts across major European CCPs, showing that a common denominator is that these are strongly procyclical and respond to the market risk of the security posted as collateral. We document that following increases in sovereign risk, haircuts set by major CCPs on peripheral sovereign bonds indeed increased during the crisis. We explore the collateral policy of the European Central Bank (ECB) during the sovereign debt crisis. The unconventional policy measures of the ECB alleviated the negative effects of the raise in CCP haircuts for repos and margin collateral during the crisis by accepting collateral at lower haircuts than those applied in the private market and by extending the maturity of its refinancing operations. Finally, we conclude with a discussion of possible measures that allow to maintain CCP haircuts at predictable levels and limit procyclicality, preserving the function of repo haircuts and margins to protect the CCP from price changes in collateral assets and member defaults.
1. INTRODUCTION
Since the onset of the global financial crisis in 2008, the refinancing patterns of European banks on the capital and interbank money markets have undergone major changes, as repurchase agreements (repos) account for an increasing share of liquidity in European financial institutions (CGFS, 2013). This is due to the heightened presence of counterparty credit risk and the need to protect the lender from the borrower’s default. Furthermore, the expansion of the liquidity operations of the European Central Bank (ECB) increased this trend towards secured funding (Houben and Slingenber, 2013).

Recently, these debt instruments have received increasing attention from the academic literature as they largely served to finance the shadow banking system in the US, but they are also a possible source of financial instability related to the pro-cyclicality of leverage (Adrian and Shin, 2009, 2010), the maturity mismatch in the balance sheets of investment banks (Brunnermeier, 2009), and the negative consequences of a rise 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 (MMF) and Security Lenders (SL) and the tri-party repo market in the US, finding controversial results contradicting the “repo run” explanation for the liquidity crisis in 2007-2009. The latter reports 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 - rather than the contraction of the repo market - was the primary cause of the breakdown of the shadow banking system. Martin et al. (2014) document that haircuts in the bilateral markets increased dramatically, whereas the 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 serving the protection of an investor do not increase sufficiently to reassure the investor. Furthermore, 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, which illustrates the pressure on the liquidity of banks in respect to margin calls related to derivatives and repo positions.

Despite numerous studies on the US repo market and its role during the US liquidity crises, few studies investigate the European repo market and existing contributions do not cover the
recent period or focus on a particular segment of this market. Hördahl and King (2008) compare the evolution of the repo market in the Euro area, US and UK for the early stage of the financial crisis. Mancini et al. (2014) and Boissel et al. (2014) investigate repo transactions performed on the principal anonymous electronic trading platforms operating in Europe (BrokerTec, Eurex Repo and MTS), reporting very accurate information on several dimensions including volumes, rates and haircuts. Molteni (2015) provides a broader picture of the European market during the crisis and shows that raises in haircuts on peripheral bonds have intensified tensions in the European sovereign debt market and tightened the link between sovereign weakness and banking fragility.

Mancini et al. (2014), who investigate the GC Pooling (GCP) repos from Eurex Repo, find that volumes, rates and haircuts of this market segment were resilient during the crisis. On the contrary, Boissel et al. (2014), who consider overnight repos collateralised by sovereign debt, find that this market became highly stressed in terms of rates and haircuts in the periphery of the Euro area in 2011. However, according to the European Repo Market Surveys published by the International Capital Market Association (ICMA), the share of these repo transactions accounts for less than one third of the total and only around one fifth of repos are overnight.\(^1\) Hence these studies provide a detailed analysis covering only one sector of the European repo market. Based on Molteni (2015), we assemble existing public information and create a novel dataset on haircuts applied by the main European central clearing counterparties (CCP) on sovereign bonds. This study provides an extensive overview of this market and its evolution during the crisis. The empirical analysis yields the following findings:

- The European repo market structure is dominated by CCPs.
- The repo market is highly 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, such as Ireland and Portugal, and to a lesser extent Italy and Spain\(^2\).

This empirical evidence raises concerns about the European repo market as a potential transmission channel of systemic risk and as an amplifier of tensions in the sovereign debt

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1 Similarly, the Euro Money Market Study (ECB, 2012), shows that around 20% of secured borrowing and lending have a maturity of one day.
2 Interestingly, LCH.Clearnet LTD considered clearing Greek bonds in late 2009, but abandoned this in early 2010 due to market conditions.
In this article, we focus on centrally cleared repos, given that CCP-cleared repos are found to be a key source of financing for European banks. In particular, we show that the repo transactions are highly concentrated between a few large banks, these transactions are cleared by a limited number of central clearing counterparties (LCH.Clearnet LTD, LCH.Clearnet SA, Eurex Repo, CC&G and BME Clearing\(^3\)) and the assets that serve as collateral consist mainly of sovereign debt instruments.

As the haircuts set by these major CCPs first and most determine the collateral flows and may significantly affect the value of the security, we analyse their haircut policy during the crisis and we emphasise the role of CCPs with regards to procyclicality and systemic risk in the sovereign debt market.

The remainder of this paper 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 calculation methodologies and haircuts during the crisis. Section 5 explores the collateral policy of the ECB during the crisis. Finally, section 6 concludes.

### 2 REPURCHASE AGREEMENTS

#### 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. In economic terms, it is analogous to a loan secured by securities. The original seller is the cash borrower - 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 defined as the repo rate, which is the difference between the repurchase price and the original sale price. The original buyer is the cash lender, typically commercial banks, investment funds, money market funds and central banks. The latter use repo to conduct monetary policy operations and to provide emergency liquidity to the market in times of crisis (for instance the three-year Long Term Financing Operations with full allotment implemented by the ECB on December 2011 and February 2012).

The party selling the security registers the transaction as a liability and the party acquiring the security as an asset (reverse repo)\(^4\). We define *private repo* as any repo transaction between

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3 Since September 10\(^{th}\), 2013, the exchange and clearing activities of the Spanish based company MEFF have been separated and are undertaken by two new companies. BME Clearing offers clearing services and the (former) MEFF offers exchange services.

4 In the US, whether a repo transaction is a repo or reverse repo is defined from the dealers’ perspective. For example, when the Fed is trying to drain liquidity from the markets, it may enter in reverse repo by “selling”
two private financial institutions (i.e. interbank liquidity) and public repo as the transaction conducted with the ECB (i.e. central bank liquidity).

Unlike a secured loan, legal title to the securities passes from the seller to the buyer, who may “re-use” the respective asset in a transaction with a third party\(^5\). The purpose of the collateral is to protect the lender against the risk of borrower’s default. Moreover, due to price volatility between regular margining dates and the probable cost of liquidating collateral following a default, repos involve over-collateralisation. The difference between the cash and the value of the collateral is the haircut or initial margin.

Repos can be divided into two categories by the way they are settled:

- **bilateral repurchase agreements** are concluded between two institutions on a “delivery versus payment” basis. The transfer of the collateral to the cash lender occurs simultaneously with the transfer of the cash to the collateral provider. The exact timing is usually not matched during the day, resulting in enormous amounts of intra-day risk for clearing banks. Hence, the cash lender must have back-office capabilities to receive, track, value, and account for the securities.

- **tri-party repo agreements**: a third party, usually a custodian bank, provides a suite of collateral management and settlement services, such as settling the repos on its book, valuing the collateral, and making sure that the collateral adheres to the lender's eligibility requirements. Thus, the cash lender does not need the back-office capability to take possession of the collateral (Adrian et al., 2014). The legal basis of the tri-party agreement is the initial bilateral agreement.

Repo transactions occur with different maturities, but the majority of repos are short-term, overnight or weekly (see ECB, 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 is agreed to without fixing any maturity date and can be terminated at any future date by either party\(^6\).

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\(^{5}\) There are legal differences between the US and the EU with regard to title transfer and re-use. More importantly, current regulation imposes stricter rules with regard to the re-usage of assets, which will lead to a shortening of collateral chains (Singh, 2011, 2012).

\(^{6}\) The vast majority of the repo transactions in the US is overnight. Two days or more is considered term repo.
The assets that serve as collateral in repos typically have low credit and liquidity risk. There are three general types of repo contracts, 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 European Central Bank, 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 funding or liquidity needs of the cash lender, while special repos are security-driven and may be part of short-selling strategies. A special repo is identified by a repo rate that is lower than the GC repo rate. The demand for some assets can become so strong that the repo rate on that particular asset falls to zero or even has negative values. Finally, credit repo is a repo using underlying collateral other than high quality securities, such as bonds issued by central governments in emerging markets.

In economic terms, 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 a source of funding for long-term activities. Moreover, the haircut forces banks to keep some fraction of their assets in reserve when they borrow money through repo markets, playing the same role as a reserve requirement for traditional banks. In addition, deposit insurance provides a guarantee for the depositors and is analogous to collateral for the cash lenders in repo transactions and repo rate remunerates the cash lenders similarly to the deposit rate for depositors. Finally, as the maturity transformation makes traditional banks subject to the risk of bank run in a Diamond-Dybvig mechanism (Diamond and Dybvig, 1983), analogously the securitised banking system faces the risk of a repo run. An increase in haircuts reduces the amount of liquidity available to banks like a massive withdrawal of deposits, causing a shortage in liquidity which may force a fire-sale of assets.

2.2 CLEARED REPO

In a cleared repo transaction, a CCP interposes itself between the cash lender and the cash borrower (novation). The CCP guarantees that the trade will be delivered to both parties of the repo agreement so that the parties in the repo transaction are not exposed to the risk that their counterparty will default, as the CCP assumes the counterparty risk (Murphy, 2013; CPSS, 2010). To protect the CCP against the default from both parties, each repo participant has to

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7 The authors define securitised banking as the business of packaging and reselling loans, with repo agreements as the main source of funding. These activities were conducted not only by the US investment banks, such as Bear Stearns, Lehman Brothers, Morgan Stanley, Merrill Lynch, but also by US commercial banks (see also Adrian and Shin, 2009, and Brunnermeier, 2009).
provide margin to the clearing house and contribute to the default fund (Pirrong, 2011). In contrast to bilateral repo transactions, a CCP typically demands margin from both the cash lender and cash borrower (CPSS, 2010). Thus, it is necessary to distinguish between the security that the borrower provides to the lender as part of the repo transaction (repo underlying security) and the collateral securities that the borrower and the lender can provide as margin to the CCP (margin collateral)\(^8\).

The exact composition of the overall margin is specific to each CCP.\(^9\) Usually, the overall margin requirement comprises the following:

- variation margin\(^10\) (VM): a component that serves to cover daily portfolio variations.
- initial margin (IM) a component that serves 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. The IM has to meet established regulatory confidence levels. In Europe, the mandatory confidence level required under EMIR is set at 99.5%. Originally, CPSS- IOSCO (2012) set the percentage to calculate the IM requirement at a confidence level of 99%.
- additional margin or add-on is often demanded on portfolio level, when a concentration limit for a deposited security is breached or the CCP estimates that there is wrong-way risk (negative correlation between issuer and provider of a security).
- additional margin to cover currency risk, if the trading currency and the currency of the margin collateral or cash are not identical.
- additional margin for clearing participants with lower credit standing or capital resources.

The IM amount is obtained from the haircut set by the CCP (see for example CC&G (2013) and Eurex (2012)). Conceptually, a distinction between the haircut applied in bilateral repos and the initial margin in CCP-cleared repos can be made. In a bilateral repo transaction, the cash amount lent is lower than the collateral asset’s market value. Market participants refer to

\(^8\)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 (see Appendix B).

\(^9\)Details on the specific composition of a CCP’s margin can be found in the respective margining methodology (see for example CC&G, 2013, and Eurex Clearing, 2012).

\(^10\)The terminology used in the context of repo clearing for the various margin components differs across CCPs.
this discount applied by the cash lender as the haircut (CGFS, 2010). In contrast, the initial margin is a percentage premium that is added to the market value of the asset (CPSS, 2010).\footnote{When initial margin is provided in securities, an additional haircut is applied to these securities to protect the CCP against possible price changes.}

As haircuts and initial margin serve the same function and their variations have similar liquidity consequences (a detailed discussion can be found in a recent report by the European Parliament (2013)), in the remainder of this paper, we refer to the initial margin and haircut as synonymous.

\textbf{2.3 Regulatory incentives}

In this section, we give a brief overview of current regulatory incentives and pieces of legislation that impact repo transactions in Europe. In the aftermath of the financial crisis, the international repo markets are being subjected to a wide range of new regulatory measures and incentives that may lead to fundamental changes in the usage of repos and the repo market structures, possibly enhancing the role of CCPs. As will be explained in detail in section 3, there are important differences between the repo market structures in the US and the Eurozone. This may also lead to slight divergences with regard to regulatory incentives and policy decisions, as already observed for the implementation of Basel III.

The Basel III framework impacts the repo markets and the market participants in many ways as it provides a set of regulatory tools consisting of liquidity, capital and leverage requirements. In particular, the Liquidity Coverage Ratio (LCR), which aims at promoting short-term resilience of a bank’s liquidity risk profile, has a direct impact on these instruments. Its impact depends on whether the market participant has a liquidity exposure under the definition of the LCR or not (BCBS, 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)). Furthermore, CGFS (2015b) notes that the LCR provides banks with strong incentives to term out their funding, which may result in a steepening of the short-term yield curve. Gorton and Muir (2015) argue that the LCR will force banks to hold government bonds as HQLAs to back their debt, leading to a
scarcity of public securities and without removing the risk of panics and runs in new forms of debts that will develop in response to the new regulations, as occurred for the bank deposits in the US National Banking Era and more recently for “shadow money” such as repos or commercial papers.\textsuperscript{12}

Having a closer look at Basel III, the treatment of repos has been a matter of controversy: for example, the June 2013 proposal of Basel III (BCBS, 2013b) did not allow for netting of securities financing transactions (SFTS), which also include repo transactions. In contrast, the revised Basel III leverage ratio framework (BCBS, 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 repos and SFTs cannot be netted, the leverage ratio would constrain banks’ leverage, which may lead to increase in clearing of repos. Altogether, the Basel III requirements may increase costs for repo trading and repo funding, besides resulting in an increase of HQL demand\textsuperscript{13}. Furthermore, Basel III enhances the liquidity position of banks and their capacity to face a funding shock, but, in times of crisis, it can reinforce the procyclicality of haircuts and amplify the negative feedback loop between the raise in haircuts and the fall in the value of the security collateral described by Brunnermeier and Pedersen (2009). Under the Basel III LCR, government bonds, which do not “have a proven record as a reliable source of liquidity in the markets (repo or sale) during stressed market conditions (f.e. maximum decline of price not exceeding 10% or increase in haircuts not exceeding 10 percentage points over a 30-day period during a relevant period of significant liquidity stress)” (BCBS (2013a), p.13), are not considered as HQLAs. As we illustrate in section 4, in times of crisis, peripheral bonds experienced considerable liquidity stress and both yields and haircuts increased more than 10%. When the creditworthiness of a government erodes and haircuts on their debt increases, banks sell off these securities, not only to avoid a cut of leverage and funding, but also to meet the new regulatory requirements, reinforcing the flight-to-liquidity towards the bonds of the core and the debt market fragmentation.

\textsuperscript{12} The problem of scarcity of government bonds as collateral is more pronounced for the Eurozone, where there is a smaller substitutability between public and private debt than in US (see Krishnamurthy and Vissing-Jorgensen (2012)) and the Quantitative Easing of the ECB will draw a considerable amount of government bonds from the market, especially French and German bonds, which are the prime collateral in the European repo market.

\textsuperscript{13} Other regulations, such as EMIR and MIFID II, affect repo activity more indirectly. For example, EMIR concerns also the general risk management framework of CCPs, such as initial margins, CCP skin-in-the-game amounts, etc.
In addition to existing regulatory frameworks, the Financial Stability Board has been especially focused on the implementation of policies in key areas associated to shadow banking (FSB, 2012, 2013, 2014a). Amongst the key recommendations that will affect repos are the following: the 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 finally the introduction of minimum regulatory haircuts. The introduction of minimum haircuts serves to address the procyclicality of haircuts associated with repos (FSB, 2012, 2013, 2014a, 2014b; European Parliament, 2013). In the first Quantitative Impact Study (QIS) on the procyclicality of haircuts (FSB, 2014b), it is revealed that haircuts for non-centrally cleared repos increased for all underlying securities during the crisis, except for government bonds. As a response to this, the regulators are currently looking to implement minimum standards for non-centrally cleared repos with non-government collateral (FSB, 2014a). This will increase funding costs for non-banks for all collateral and could lead to a reduction in trading activity in the private markets.

The introduction of the European Financial Transaction Tax (FTT) is to be finalised soon. The FTT foresees a transaction tax for financial transactions, including repo (European Commission, 2013a). The FTT legislation is supposed to take effect as of January 2016, although there are certain exemptions, certain types of repo transactions may be subject to the FTT (European Commission, 2013b). Besides the fact that the FTT would only be applied by 11 member states, thus only covering 66% of the EU market (Comotto, 2013), the expected negative impacts for the repo markets include overall volume decline, vanishing of overnight repos and decrease of available liquidity. According to Gabor (2013), resistance formed amongst member states, central bankers, financial institutions and the repo interest groups.

As we have seen, regulators aim at minimising the systemic risks inherent to repos, discourage runs, and seem to promote resilient structures by rendering repo clearing via CCPs more attractive. Finally, clearing institutions themselves are prone to become sources of systemic risk: the systemic importance of clearing banks, CCPs and dealer banks must also be considered in case such an institution fails and needs to be resolved or recovered. In Europe\textsuperscript{14}\textsuperscript{15}, current regulation does not cover the resolution or recovery of CCPs. Thus, the regulators must carefully consider the consequences of a possible boost in repo clearing.

\textsuperscript{14} Only in the UK, the Financial Services Act prescribes resolution and recovery tools.
3 THE EUROPEAN REPO MARKET

The lack of comprehensive and standardised information on the European repo market within individual institutions and within the financial system makes arduous a deep and general analysis of this market. In this study, we rely on the following sources of publicly available data to analyse the size, the evolution, the collateral pool and the structure of the European repo market:

- Bankscope and SNL financial data: databases on banks’ balance sheets at yearly and quarterly frequency.
- Euro Money Market Survey (EMMS): yearly survey published by the ECB since 2002, covering a constant panel of 104 banks.

The European repo market expanded significantly over the last decade, especially in the run-up to the global financial crisis. Figure 1 shows the amount of repos in the balance sheet liabilities of European banks (excluding reverse repos) that participated continuously in all the

15 In the US, the failure of a CCP cannot be concluded safely nor effectively under the current available forms of bankruptcy, nor under the Dodd-Frank Act’s Title II administrative failure resolution (Duffie, 2010, 2014). Most importantly, it is not clear, how the exemption of repos from the Bankruptcy Code’s ‘automatic stay’ would apply in the case of a CCP failure (Duffie and Skeel, 2012).
ERMS. The volume of repos tripled between June 2001 and December 2007 from around €0.92 trillions to around €3.44 trillions. In the first stage of the global financial crisis, it contracted to €2.79 trillions in December 2009, but it recovered 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 reported by the Federal Reserve Bank by the Federal Reserve Bank of New York in 2009 (Acharya and Öncü, 2013). A similar evolution can be observed for the French repo market (see Box 1).

**BOX 1 : THE FRENCH REPO MARKET**

The French repo market is one of the oldest in the Euro area. In July 1994, twelve primary dealers in government securities ("spécialistes de la pension sur valeurs du Trésor"(SPVTs)) were appointed as primary dealers in government repos to foster development of a liquid and efficient repo market. In February 1996, the Treasury decided to merge the SPVTs with the SVTs. Thus, this activity fits presently in the market-making activity carried out by all SVTs in French government securities.

Figure 2 displays the monthly volume of French government securities repo transactions from 2005 to 2013. Two main results stand out. Firstly, repo volumes are almost five times higher than pre-crisis. Secondly, most repos have an extremely short maturity between 1 and 3 days.

**Figure 2 Monthly transactions in the French repo market**

Repos have become a key source of liquidity for European financial institutions. Table 1 displays the funding structures of the major commercial banks for which information on repo activities is available via Bankscope. As noted by Boissel et al. (2014), the European repo
market corresponds to the secured interbank market. Thus, the banks’ balance sheets give a broad picture of the volume of repos in this market. Nevertheless, the data reported by Bankscope includes repos transacted with the ECB. For this reason, we analyse the data in 2010 before the two large-scale LTROs in December 2011 and February 2012 took place. Repos turn out to be a key source of funding, in particular for the five largest institutions in the sample. The biggest banks hold a considerable high fraction on repos in their balance sheet (more than 10% of their liabilities) and for most of the European banks secured funding accounts for a larger share than unsecured funding: BNP Paribas, Barclays Bank Plc., Banco Santander, Société Generale, UBS AG, Banco Bilbao, Bankia SA, KBC and Banca MPS.

Table 1 Funding structure of the European banks (in percentage of the total liabilities)

<table>
<thead>
<tr>
<th>BANK</th>
<th>Deposits</th>
<th>Bonds</th>
<th>Repos</th>
<th>Interbank</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNP Paribas</td>
<td>26.62</td>
<td>6.19</td>
<td>10.48</td>
<td>7.07</td>
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<tr>
<td>Barclays Bank Plc</td>
<td>23.41</td>
<td>9.89</td>
<td>13.26</td>
<td>5.89</td>
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<td>Banco Santander</td>
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<td>16.92</td>
<td>9.60</td>
<td>4.69</td>
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<td>Société Generale</td>
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<td>8.74</td>
<td>9.58</td>
<td>7.62</td>
</tr>
<tr>
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<td>10.04</td>
<td>12.52</td>
<td>2.13</td>
</tr>
<tr>
<td>UniCredit SpA</td>
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<td>16.96</td>
<td>3.39</td>
<td>10.83</td>
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<td>16.96</td>
<td>3.39</td>
<td>10.83</td>
</tr>
<tr>
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<td>5.61</td>
<td>10.63</td>
</tr>
<tr>
<td>Intesa Sanpaolo</td>
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<td>27.99</td>
<td>1.99</td>
<td>10.32</td>
</tr>
<tr>
<td>Banco Bilbao</td>
<td>43.79</td>
<td>14.16</td>
<td>8.89</td>
<td>6.01</td>
</tr>
<tr>
<td>Commerzbank AG</td>
<td>34.32</td>
<td>13.72</td>
<td>7.13</td>
<td>12.01</td>
</tr>
<tr>
<td>Bankia, SA</td>
<td>36.78</td>
<td>29.60</td>
<td>11.56</td>
<td>3.43</td>
</tr>
<tr>
<td>Fortis Bank</td>
<td>41.18</td>
<td>5.50</td>
<td>4.30</td>
<td>7.68</td>
</tr>
<tr>
<td>ABTS Plc</td>
<td>2.79</td>
<td>13.42</td>
<td>13.85</td>
<td>52.99</td>
</tr>
<tr>
<td>KBC</td>
<td>50.76</td>
<td>10.58</td>
<td>8.53</td>
<td>7.35</td>
</tr>
<tr>
<td>Banca MPS</td>
<td>32.35</td>
<td>24.56</td>
<td>9.86</td>
<td>9.41</td>
</tr>
</tbody>
</table>


This is in line with the findings of the EMMS (ECB, 2012), which reports that from 2008 to 2012, the unsecured market contracted steadily and that in the same period a switch between unsecured and secured lending took place (see figure 4). The diverging evolution of the two markets follows the decoupling of interest rates between the unsecured and the secured
markets during the crisis as documented by 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 bilateral secured transactions, respectively, suggesting that the volume of the European repo market is highly concentrated between few financial institutions.

Concerning the market structure, European repos are predominately bilateral and only a fraction of around 10% is composed of trilateral repos, marking a significant difference to the US repo market, in which approximately 70% of the repos are managed by a tri-party provider\textsuperscript{16} (Copeland et al., 2012a). 71% of all bilateral repo transactions are cleared by central counterparties, following a growing trend since 2009 (see figure 5). The continued decline in the share of unsecured lending, as well as the increase in the share of repos in particular settled though a CCP, reflects concerns about counterparty credit risk.

Figure 6 shows the volume of repos cleared by the CCPs. The European repo market is dominated by five main CCPs: LCH.Clearnet SA (Paris), LCH.Clearnet LTD (London), EUREX Clearing AG (Frankfurt), Cassa di Compensazione e Garanzia SpA (Rome) and BME Clearing (Madrid). The vast majority of European repos are cleared via CCPs that are part of the London Stock Exchange Group: LCH.Clearnet LTD, LCH.Clearnet SA and Cassa di Compensazione e Garanzia SpA.

\textsuperscript{16} According to Copeland et al. (2012b), the US tri-party repos markets consists of two main segments: tri-party repos funded by non-dealers (money market funds, securities lenders,...) and the General Collateral Finance (GFC) segment, a blind-brokered inter-dealer market.
To sum up, we observe a rapid expansion of the European repo market in the last decade, reaching a size comparable with the U.S. repo market, as well as a radical transformation in the interbank market during the crisis given the surge of the CCPs to facilitate interbank liquidity. Similar to the effects of the bankruptcy privileges granted in 2005 to overnight secured credit which contributed to the growth of the U.S. repo market (Perotti, 2010), CCPs—by mitigating counterparty credit risk inherent to repos—may have fostered the development
of the European repo market. Given their relevance in the European interbank market, we focus on the analysis of the principal CCPs and their functioning in the next section.

Our work is complementary to the Financial Stability Board (2014), which examines non-centrally cleared securities financing transactions and their role during the global financial crisis in nine jurisdictions. The respective analysis is based on a survey of 11 global financial intermediaries (banks and securities broker-dealers) and considers information on reverse repos excluding centrally cleared transactions. It finds that 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 documented in figure 5- seems to confirm these findings for the European jurisdiction. A stark contrast between the two analyses concerns the evolution of haircuts during the crisis. The Financial Stability Board (2014) finds that the 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 countries of the Eurozone sharply augmented during the crisis.

Interestingly, the use of government securities as collateral in the European 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.

4 CLEARING HOUSES AND REPO HAIRCUTS

4.1 REPO HAIRCUT METHODOLOGIES ACROSS CCPs

In general, haircut calculation methodologies are based on quantitative and qualitative factors, such as VaR measures, liquidity measures, the credit rating of the collateral or the rating of the issuer, the maturity of the collateral, benchmark haircuts set by central banks (European Parliament, 2013; CGFS, 2010). 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

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17 The special bankruptcy treatment given repos and derivatives means that repo lenders and parties to derivative contracts can keep the collateral if their trading partner becomes insolvent. This exempts them from the “automatic stay” rule in bankruptcy, which prohibits most creditors from trying to collect ahead of others.

18 Australia, Brazil, Germany, France, Italy, Japan, Netherlands, UK and US.
level, maturity, historical and hypothetical future price volatility, market liquidity, FX risk) and wrong way risk (ECB, 2013).

In this section, we discuss haircut calculation methodologies applied by major European CCPs in different repo segments, such as GC Pooling and classic repos. The CCPs are briefly introduced and an overview of the publicly available information on the respective repo haircut calculation methodology is provided.

**Eurex Repo** is an electronic platform for repos and securities lending. Eurex Repo offers trading, clearing and settlement services within the GC and special repo segment. After trade execution, post-trade services, such as margining, are performed by Deutsche Boerse Group’s CCP, Eurex Clearing AG. We study haircuts applied to sovereign debt instruments in the GCP ECB basket, which are based on the ECB’s benchmark haircuts (see Table 2). The range of securities eligible for the GCP ECB basket\(^\text{19}\) is based on the collateral framework of the ECB’s open-market operations. The basket comprises around 7500 securities. The following issuer countries are eligible: Austria, Belgium, Finland, France, Germany, Luxembourg, Netherlands, Slovakia and Slovenia.

**Table 2. Haircuts applied by the ECB to 10-year government securities**

<table>
<thead>
<tr>
<th>Date</th>
<th>Credit Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/02/2009</td>
<td>AAA to A-</td>
</tr>
<tr>
<td>01/01/2011</td>
<td>4%</td>
</tr>
<tr>
<td>01/10/2013</td>
<td>3%</td>
</tr>
<tr>
<td>01/02/2009</td>
<td>BBB+ to BB-</td>
</tr>
<tr>
<td>01/01/2011</td>
<td>4%</td>
</tr>
<tr>
<td>01/10/2013</td>
<td>11.5%</td>
</tr>
</tbody>
</table>

*Source: European Central Bank*

Given the rare revision of ECB haircuts and the independence of daily or even monthly changes in market conditions (see Nyborg (2015)), Eurex Clearing conducts its own risk assessment, which may lead to a raise in haircuts (Eurex Repo, 2012), resulting in higher haircuts than those of the ECB.

\(^{19}\) In 2015, the definition of the GCP ECB basket was revised and the basket collateral criteria were adapted to Liquidity Coverage Ratio Level 1 criteria, which narrowed down the range of eligible collateral to about 4000 eligible securities.

\(^{20}\) The distinction according to credit quality was introduced in 2011.
To adapt the CCP from a decline in the value of the collateral, securities in the GC ECB basket that do not adhere to the following credit rating requirements are excluded from the basket: at least an ‘A-’ from Standard and Poor’s/Fitch Ratings or an ‘A3’ from Moody’s. If multiple ratings are available for the same issuer, the lowest rating is considered (Eurex Repo, 2015). Until January 27th 2012, the GCP ECB basket also included Italian bonds (Eurex Repo, 2012). These were excluded from the basket as the issuer was downgraded (see Appendix A). The cash taker can re-use the received collateral for refinancing within ECB framework, the Eurex GCP market and for clearing margin.

The London Stock Exchange Group (LSEG) comprises several trading platforms. For repo clearing, the following three CCPs are available: LCH.Clearnet LTD in London, LCH.Clearnet SA in Paris and Cassa di Compensazione e Garanzia (CC&G) in Rome. In order to assess how the haircuts are determined, we rely on general documentation and information from the risk notices on the website of the LCH.Clearnet Group. The calibration of the margin parameters is based on the so-called Sovereign Risk Framework. The methodologies used are not exactly the same: Given that LCH.Clearnet SA and CC&G have an inter-operability agreement enabling members from both CCPs to enter into repo transactions with each other directly, both CCPs use the same methodology for setting repo haircuts.

The range of eligible assets for repo clearing at LCH.Clearnet LTD’s RepoClear comprises the following issuers of government debt: Austrian, Belgian, Dutch, German, Irish, Finnish, Portuguese, Slovakian, Slovenian, Spanish and UK government bonds. 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, an increase in the order of 15% of the position’s size is applied, corresponding to a haircut of 15% (LCH.Clearnet Group LTD, 2010). Indicators in CDS prices or market implied rating data are used to assess whether additional margin is required (LCH.Clearnet Group LTD, 2014).

LCH.Clearnet SA’s range of eligible assets for classic repos consists of French, Italian and Spanish government debt, whereas CC&G only clears Italian government debt. In this paper, we consider haircuts applied to sovereign debt instruments by LCH.Clearnet LTD.

\[^{21}\text{A security that is not accepted as collateral is assigned a 100\% haircut to account for ineligibility.}\]
LCH.Clearnet SA and CC&G in classical repo transactions\textsuperscript{22}. 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 (CC&G, 2012).

![Figure 7 Sovereign 5-years CDS](image)

**4.2 Haircut Levels and Eligible Collateral During the Crisis**

In this section we assess how CCPs set haircuts applied to government bonds during the sovereign debt crises in the Eurozone, as well as their policy concerning the eligibility of collateral. For this purpose, we focus on government bonds with 10-year maturity. The information on haircuts and collateral eligibility was assessed on the CCP’s website or directly provided by the respective risk management unit. The empirical findings allow the categorisation of government bonds according to haircut level during the crisis: bonds issued by European core countries (France and Germany), for which the haircuts remained rather stable, Italian and Spanish bonds, which experienced considerable raises in haircuts, and Irish and Portuguese bonds, for which the haircuts reached extremely high levels of haircuts. Finally, one may think of those bonds, which were not accepted by CCPs or excluded from repo clearing, as being assigned a haircut of 100%.

**Italian and Spanish bonds** Haircuts on Italian debt were increased several times by LCH.Clearnet SA and CC&G, who both use the same methodology to determine repo haircuts. Figure 8 shows the jump of the haircut applied by LCH.Clearnet SA and CC&G.

\textsuperscript{22} Besides classical repo trades, LCH.Clearnet LTD and LCH.Clearnet SA also offer a wide range of collateral baskets, for a detailed overview we refer to a recent study of the ECB on collateral frameworks (ECB, 2013).
from 6.65% to 11.65% on 9th November 2011 during the most acute phase of the tensions on the Italian debt market, when the yields reached their peak. Following the reduction in the bond yields, the haircut decreased to 8.3% between January and June 2012 and rose again to 11.65% on 23rd July 2012.

The increase in the haircut on the Italian government bonds by LCH.Clearnet SA and CC&G may also be based on considerations regarding the increase in cross-border transactions between the members of both CCPs via the inter-operability agreement. As the volume of Italian government repos intermediated by the two CCPs on Mercato dei Titoli di Stato (MTS) - the world's largest electronic trading platform for sovereign bonds - highly increased throughout 2012 and 2013 (Banca d’Italia, 2013b), the exposure of both CCPs to each other highly increased as well. This may also explain why the haircut on Italian government bond was maintained at such a high level (Banca d’Italia, 2013a). Although the increase in haircuts on Italian bonds was not as high as for Irish and Portuguese bonds, they had a significant impact on the value of Italian debt market, which is the largest in Europe, and its share on the collateral of the repo market (see Molteni, 2015).

LCH.Clearnet SA also increased the haircut on Spanish government bonds in 2012 from 8.53% in January 2012 to 12.2% in July 2012, reaching a similar level of those on Italian bonds, and went down to 8.5% in August 2014.

In contrast, since Italian debt was downgraded to ‘BBB+’ on January 13th (see Appendix A for an overview of rating changes), Italian bonds were excluded from the Eurex GCP ECB basket
(Eurex Repo, 2012), as their rating was below the pre-defined minimum rating. A collateral framework, such as the GCP ECB basket, that uses central bank haircuts (see Table 2), 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, when the quality or liquidity of a bond falls below a certain threshold.

**Irish and Portuguese bonds** A more striking sequence of rises in haircuts was observed for Irish and Portuguese bonds. Figure 9 shows that the dynamic of the respective haircut tracks that of the bond yields closely. The haircut on Irish bonds increased from 15% to 80% between November 2010 and June 2011 and went back to 15% in February 2012. On 1st April 2011, Ireland was downgraded from rating of ‘A-’ to a ‘BBB+’ (see Appendix A). On the same day LCH.Clearnet LTD increased the haircut to 45% from an initial 35% and decreased it again to 35% on 13th April 2011, suggesting the haircut was set as a function of the spread rather than the sovereign rating. 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.

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 reflected the widening of the yield spread, while the double downgrade in March 2011 from

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an initial ‘A-’ to 'BBB-' did not lead to a rise in the haircut. Eurex Repo went as far as to exclude bonds with Portugal being the issuer residence and country of location from all its’ repo markets in January 2012 (Eurex Repo, 2012). This would correspond to a haircut of 100%. The increase of CCP haircuts on Irish and Portuguese government bonds in 2010 and especially in 2011 led to a significant decline in CCP cleared repo trades for both securities, causing CCP repo activity to almost cease for both securities in 2011 (Boissel et al., 2014; Morgan Stanley Research, 2011).

The increases in haircuts on peripheral bonds have two important economic consequences. First, they shrink the amount of funding that financial institutions could obtain by posting these assets as collateral. For instance, if before the crisis a bank could borrow 85 euros by pledging a portfolio of Irish and Portuguese bonds which was worth 100 euros, in the midst of the crisis with the same value of collateral securities they could borrow only 20 euros. Second, the raises in haircuts cut the maximum leverage of financial institutions. Acharya and Steffen (2015) argue that during the period 2007 – 2013 European banks engaged in carry trades by borrowing in the short-term wholesale funding and investing in long-term peripheral government bonds. Using micro-level data on collateral tendered to the ECB during the period 2007-2011, Drechsler et al. (2014) find that European banks increased their holdings of distressed government bonds by about 45% of the amount of increase in their pledging of distressed government bonds to the ECB.

Since banks fund their bond purchases mainly via repos (see Figure 4), the haircut also determines the maximum possible leverage: before the crisis in order to purchase Irish and Portuguese bonds which were worth 100 euros, banks could borrow up to 85 euros 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 of LCH.Clearnet LTD on these securities spiked to 80%, the leverage fell to only 1.25.

The prolonged periods of low yields and risk premia on peripheral bonds before the crisis 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 the yields and haircuts exacerbating the deleveraging during the crisis. Thus, the pro-cyclicality of
haircuts in the private markets\textsuperscript{24} reinforces the pro-cyclicality of leverage and consequently of the asset prices (Adrian and Shin, 2009).\textsuperscript{25}

This anecdotal evidence on Italian, Spanish, Irish and Portuguese sovereign bonds also suggests the presence of a strong feedback between level of haircuts and bond yields. Initially, the increases in the yields affect the level of haircuts since the CCPs increased them to mitigate the counterparty credit risk. However, the rises in haircuts reduce both the funding and the leverage of banks, which borrow cash by pledging these securities and they are forced to sell the bonds with the heightened margin, this way exacerbating the downward spiral and reinforcing the raise in the bond yields, following the mechanism of the “margin spiral” theory developed by Brunnermeier and Pedersen (2009).

Moreover, the structure of the repo market and the functioning of CCPs reinforce this mechanism in two ways. Since both the cash lender and the cash borrower have to provide margin to the CCP, a raise in the haircut applied to margin collateral makes the posted security less liquid for both parties and increases funding costs for the margin requirement. Figure 10 shows the minimum haircuts\textsuperscript{26} applied by Eurex Clearing AG to government bonds that are 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 (about 3%). As the sovereign debt crisis began to unfold throughout 2010 and 2011, the haircuts on these securities were notably increased.

In analogy to the rises in repo haircuts, we can observe that the margin haircuts for Italian and Spanish government bonds rose considerably, whereas the margin haircuts for Portuguese and Spanish 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 minimum margin haircut of 22.3%. Moreover, from late September 2011 to late February 2012, Eurex Clearing AG applied a minimum margin haircut of 59.5% to Irish and Portuguese government bonds. In contrast, the minimum margin haircut for high quality government bonds, such as French and German, remained rather stable at around 3% throughout the crisis.

\textsuperscript{24} As shown by Koulischer and Struyven (2015), the ability of a central bank to alleviate such pro-cyclical 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.

\textsuperscript{25} Kalemli-Ozcan et al. (2012) show that leverage is procyclical for large commercial banks in the United States and in Europe.

\textsuperscript{26} The displayed haircuts are minimum haircuts in the sense that the haircuts tend to be much higher the longer the maturity of the respective bond.
As shown in Figure 1, the margin haircuts applied by CC&G to Italian government bonds with a 10 year maturity never fell below 16% for the period from March 2010 until August 2013, reaching its peak in September 2011 at 26.6%. In contrast to Eurex Clearing AG, the margin haircuts for French and German remained rather high at around 15% throughout the crisis. With the introduction of a new collateral framework in September 2013, the margin parameters for French and German securities were indeed reduced to about 4%.

Given the similar development in haircut increases for repos and collateral securities, margin haircuts may be a further factor contributing to the magnification of the downward margin spiral and thus leading to a further amplification of raises in bond yields. As both the cash lender and the borrower face higher funding costs to cover increasing margin requirements,
both have an incentive to sell the less liquid assets, in particular in times of crisis when their capital is scarcer. The fire-sale of less liquid assets is therefore amplified.

In addition, since 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\textsuperscript{27}; when a CCP raises the repo haircut and the margin haircut on sovereign debt, banks will tend to react synchronically with a stronger impact on the price of the bond. Consequently, in a highly concentrated secured interbank market, a liquidity shock, such as haircut increases, amplifies and spreads throughout the system via interbank linkages. Sever (2014) explores the effects of static and dynamically updated haircuts on the interbank market by analysing effects of connectivity, balance sheet and network positions of banks. He finds that highly connected banks, which are hit by an idiosyncratic shock combined with an increase in haircuts have to withdraw their assets from the interbank market.

5 The collateral policy of the European Central Bank during the crisis
In the previous section we have shown that increases in haircuts on peripheral sovereign bonds applied by the main clearing houses in the European repo market during the crisis may have contributed to the pro-cyclicality of the financial system intensifying the stress on sovereign debt markets. We now turn to assess whether the unconventional policies implemented by the European Central Bank may have alleviated the impact of rises in repo haircuts on peripheral bonds by providing an alternative source of funding for banks which could pledge peripheral bonds to the ECB instead of addressing the private repo market.

The ECB put in place several non-standard measures in the aftermath of the crisis affecting the interbank market and the secured market directly:

i) The introduction of fixed-rate full allotment tender procedures in the refinancing operations

ii) The expansion of the list of eligible collateral

iii) The Long-Term Refinancing Operations (LTROs) with maturity up to three years.

iv) Emergency Liquidity Assistance (ELA).

\textsuperscript{27} Clearing members are informed in advance of upcoming haircut changes either via internal messages or circulars.
These policies succeeded in supporting the impaired interbank market, since banks could entirely meet their demand of liquidity by borrowing cheap funding from the ECB or National Central Banks (NCB) in case of ELA (see Lenza et al., 2010, and Darracq Pariès and De Santis, 2013). Moreover, by posting a larger range of securities as collateral they could relax their liquidity and collateral constraints, since some of their assets, such as ABS, could not be pledged in the private money market. Moreover, Mayordome et al. (2015) document that fragmentation in the European interbank market significantly decreased after the Securities Market Programme (SMP) and the 3-years LTROs.

Further, these measures indirectly mitigated the pressure on sovereign bonds as banks in the periphery could finance governments by borrowing longer-term loans from the ECB through 3-year LTROs in carry trade operations. More than 70% of liquidity injected by the ECB in the banking system has been absorbed by banks in Spain, Italy, Ireland, Greece and Portugal (Claeys, 2014).

However, it is controversial to which extent the ECB collateral policy mitigated the tensions on peripheral sovereign debt markets deriving from 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. Nevertheless, before the crisis less than 20% of the effective posted collateral was composed by 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 eligible assets with liquid securities (government securities) as collateral for Eurosystem refinancing operations before the crisis reflecting structural changes in the interbank market. This trend intensified during the crisis when illiquid private asset collateral was migrated towards the ECB following the extension of eligible collateral and the possibility for banks to pledge low-rated securities (European Central Bank, 2010b). Cassola and Koulischer (2014) show that during the period between January 2009 and September 2011 government bonds accounted for only 14% of total pledged assets compared with 34%.

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28 See Acharya and Steffen (2015) and Coimbra (2014) for a discussion on the implications of the LTROs for the European sovereign debt crisis.
29 Drechsler et al. (2014) document that after May 2010 about a third of government debt issued by distressed sovereigns and pledged to the ECB moved from strongly-capitalised banks to weakly-capitalised banks. They show that especially weakly-capitalised banks significantly increased borrowing from the ECB using riskier collateral.
of ABS, which in 2008 were less than 10% of total securities posted in main refinancing operations.

One of the main reasons for which banks preferred posting public bonds as collateral for the repo market and private assets for ECB refinancing operations is that the repo rates were substantially lower than the main refinancing operation (MRO) rate and because some securities were not accepted as collateral in the interbank market, but could be pledged for ECB loans. Mancini at al. (2014) show that rates on interbank transactions performed on an anonymous electronic trading platform 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 that the CCP-based euro interbank repo market was perceived as a safe harbor to hoard liquidity in times of stress. Similarly, Boissel et al. (2014) 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 during the period between June 2011 and December 2012 and they were more sensitive to the sovereign risk.

The difference between the MRO rate and the repo rates makes the two sources of funding non substitutes for financial institutions.\textsuperscript{30} Therefore, when CCPs increased the haircuts on peripheral government securities, banks had an incentive to shift their portfolios towards low-haircut bonds rather than pledge the high-haircut bonds for the ECB refinancing operations at a penalty rate. Indeed, we do not observe - during the most acute phase of the sovereign-debt crisis in 2010-2012 - a massive collateral flow of government bonds from the private repo market towards the ECB (European Central Bank, 2013), even though it is possible a change in the composition of collateral bonds and an increase in the share of peripheral bonds.

The stance of the collateral policy of the ECB during the crisis is ambiguous. On the one hand, it accepted a wider range of securities as collateral and suspended the minimum rating threshold for Greek (in May 2010 (European Central Bank, 2010a)), Irish (in March 2011 (European Central Bank, 2011a)) and Portuguese (in July 2011 (European Central Bank, 2011b)) 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.

\textsuperscript{30} In addition, banks that rely on large amounts of ECB liquidity receive a worse rating ceteris paribus (Standard and Poor’s, 2011) and can face stigma issues, limiting de facto the possibility to borrow from the ECB.
Recent studies find a strong elasticity of security yields to central banks haircuts, which act as powerful instrument of monetary policy. Ashraft et al. (2010) provide empirical evidence that in US the introduction of the Term Asset-Backed Securities Loan Facility (TALF) program by lowering the haircuts brought down the required returns of eligible collateral. Further, 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. Corradin and Rodriguez-Moreno (2014) show that a large yield spread between USD- and Euro-denominated bonds can be explained by different ECB haircuts which generate a significant monetary funding premium. Cassola and Koulischer (2014) argue that when the amount or the quality of the available collateral reduces and the lack of good collateral prevents borrowing, the collateral policy of the central bank can affect the lending activity, and it is optimal for the central bank to relax its collateral requirements to avoid a credit crunch. In their simulation, they show 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. CGFS (2015a) 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.

All in all, 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 rates. 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 the pro-cyclicality and the fragmentations of financial markets. 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. The impact of these margin variations and the optimal trade-off between risk protection and funding liquidity deserve more future research.

On the other hand, Chapman et al. (2011) argue that the level of haircut entails a trade-off between relaxing the liquidity constraints of agents and increasing potential inflation risk and distorting the portfolio choices of agents. Buiter and Sibert (2005) criticize that all sovereign debt was placed in the same category suggesting that all government bonds had the same liquidity weakening the fiscal discipline in the Eurozone.
6 CONCLUSION

In this paper we have explored the CCP-cleared repo market, which is rapidly expanding in contrast to the shrinking of the unsecured interbank market. We have studied the structure, the main actors and the procedures followed to set the haircuts in the cleared market. The strong concentration of this segment and the procyclicality of haircuts raise several concerns regarding systemic risk.

Policymakers and regulators are aware of the implications of the different repo market segments for systemic risk. Regarding the cleared segment, 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 pro-cyclical 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). The Financial Stability Board (2014) recommends imposing a numerical haircut floor applied to non-centrally cleared SFTs. That proposal excludes transactions backed by government securities because “price movements in these securities generally tend not to be procyclical” and centrally-cleared securities financing transactions 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, the size of the CCP-cleared repo market has become much larger than that of unsecured and non-CCP cleared repo markets. However, little information is available on these intermediaries, on how they set haircuts and how they acted in time of crisis. Because of their systemic importance, macro-prudential authorities and financial regulators should monitor their activity more closely.32

Furthermore, contrary to the claim of the FSB (2014), 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 their sovereign risk. Due to the extensive use of

32 Tarullo (2015) argues that “CCP margining practices may have a significantly procyclical character that could be problematic in deteriorating financial conditions”.
sovereign bonds as collateral, stress in the European repo market jeopardises the financial stability even more, because it creates an additional channel which ties the bank-sovereign nexus (Molteni, 2015). Peripheral banks augmented their exposure on domestic sovereign bonds (Gennaioli et al., 2014) after the onset of the global financial crisis and increasingly pledged these assets in the interbank market, since the unsecured market shrank. However, the raises in haircuts on government bond reduced the funding liquidity of banks (Miglietta et al. 2015). This was in part offset by the unconventional policy implemented by 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.

In analogy to the introduction of countercyclical capital buffers as part 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. Alternatively, market participants and CCPs may use insurance-like mechanisms to protect themselves from increases in haircuts in times of stressed markets.

Similarly to accepting low quality collateral in its role as lender of last resort for banks, the ECB could intervene, when CCPs increase haircuts on such assets. For example, it could enable CCPs to exchange government bonds, whose quality erodes drastically, against higher quality assets (collateral swap) against a fee.

Reducing the procyclicality of repo haircuts to bonds 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) for an extensive discussion) – 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 time 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.
Appendix A

The collateral framework of Eurex Clearing AG for the GC ECB basket includes a minimum credit rating threshold for securities eligible for this basket (see Box 2). As accurate credit rating information is not available for the respective government bonds, we use the credit rating of the respective sovereign in the category ‘Foreign Currency Longterm Debt’ from Standard & Poor’s to illustrate the eligibility criteria of Eurex Clearing AG.

<table>
<thead>
<tr>
<th>Country</th>
<th>Date</th>
<th>Rating change</th>
<th>Changes in eligibility for EurexRepo markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland</td>
<td>8 June 2009</td>
<td>AA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 August 2010</td>
<td>AA-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>23 November 2010</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 February 2011</td>
<td>A-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 April 2011</td>
<td>BBB+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 June 2014</td>
<td>A-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 December 2014</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>19 October 2006</td>
<td>A+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19 September 2011</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 January 2012</td>
<td>BBB+</td>
<td>Bonds with issuer residence and country of location Italy are excluded from the GC Pooling ECB basket on 27th February 2012</td>
</tr>
<tr>
<td></td>
<td>9 July 2013</td>
<td>BBB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 December 2014</td>
<td>BBB-</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>05 December 2011</td>
<td>AAA</td>
<td>No changes</td>
</tr>
<tr>
<td></td>
<td>13 January 2012</td>
<td>AA+</td>
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</tr>
<tr>
<td></td>
<td>8 November 2013</td>
<td>AA</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>19 January 2009</td>
<td>AA+</td>
<td></td>
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<tr>
<td></td>
<td>28 April 2010</td>
<td>AA</td>
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<tr>
<td></td>
<td>13 October 2011</td>
<td>AA-</td>
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<td></td>
<td>13 January 2012</td>
<td>A</td>
<td></td>
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<tr>
<td></td>
<td>26 April 2012</td>
<td>BBB+</td>
<td></td>
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<tr>
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<td>16 October 2012</td>
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<td>23 May 2014</td>
<td>BBB</td>
<td></td>
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<tr>
<td>Portugal</td>
<td>21 January 2009</td>
<td>A+</td>
<td>Bonds with issuer residence and country of location Portugal are excluded from all Eurex</td>
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<td></td>
<td>27 April 2010</td>
<td>A-</td>
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</tbody>
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Appendix B

We provide a basic overview of bilateral and cleared repo transactions. We consider the following situation for bilateral and cleared repos: a cash provider, called party A, and a collateral provider, called party B, conclude a repo transaction. The underlying security is a French government bond with 2 years maturity. The value of the security is 100€ and the repo rate, denoted by R, is equal to 2%. The haircut is denoted by H.

B.1 Private bilateral repos

As described above, A and B have concluded a repo transaction on the private market. A sets the haircut for a repo trade - with a French government bond with a maturity of two years as underlying and concluded with counterparty B - at 5%.

In the front leg, B transfers the security with value X to A (see Figure B.1). In a private repo, the cash provider deducts the haircut directly from the amount to be lent. Thus, A transfers a cash amount of X-H to B. In our example, B receives 100€-5€=95€.

In the term leg, B transfers an amount of (X-H)*(1+R), corresponding to the cash amount lent and the repo rate on the amount, to A. In our example, A receives (100€-5€)*(1+0.02) = 96.9€. A then re-transfers the security to B.

Figure B.1 Front and term leg of a private bilateral repo
A and B have concluded a repo trade on an electronic trading platform, such as EurexRepo or MTS Italy. The contracts are then directly novated to the CCP, which performs the daily risk evaluation and risk monitoring (for a detailed overview see EurexRepo (2012) and CC&G (2013)).

The CCP applies a haircut of 3% to French government bonds with a maturity of two years. The trade amount of the repo contract, denoted by $X$, is 100€. The IM amount for the respective position of A and B, is equal to the haircut $H$. The front and the term leg are divided into a cash and a security leg, referring, respectively, to the cash amount and the security associated part of each transaction leg (see Figure B.2.1).

In the security of the front leg, B transfers the underlying security and pays the IM to the CCP, which corresponds to an amount of $X+H= 103€$. The CCP passes $X+H$ on to A. Then, in the cash leg, A transfers $X+2H=106€$ to the CCP. $X$ is the cash amount of the repo transaction. As A has already received $X+H$ from the CCP, A’s IM is equal to $2H$. The CCP retains 6€ of IM.

Figure B.2.1 Front and term leg of a cleared repo
In the cash leg of the term leg, B provides the cash amount and the interest to be paid, thus \(X(1+R) = 102€\) to A via the CCP. In the security leg, A passes the security and the haircut to B via the CCP. Finally, the CCP returns the 2H to A.

Margin requirements can be met either in cash or by posting collateral. If the clearing member provides securities to cover the requirement, the CCP will apply a haircut to the posted securities. In our example, the IM requirement is equal to \(H=3€\). Let us consider the following: the clearing member chooses to post Italian government bonds with a maturity of 10 years. The CCP applies a haircut of 20\% to the respective security when used as margin collateral. Thus, to cover the 3€ IM requirement, the clearing member will have to deposit Italian government bonds with a maturity of 10 years for a minimum market value of 3€80\%=3,75€.

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