The European CCP ecosystem☆☆

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Abstract

This paper provides a description of the EU centrally cleared markets. Based on data available under the Public Quantitative Disclosure framework (PQD) and further public data sources, we document aspects of central clearing counterparty (CCP) operations, such as member bases, asset classes cleared, transaction amounts, default waterfall resources, and the liquidity of the resources contained in the default waterfall. We also explore liquidity management of pre-funded default resources and CCP reinvestment strategies for participants' cash. Based on the analysis of the issues encountered when using PQD data, we propose a set of policy measures aimed at improving the reliability of the PQD data and possible usage for systemic risk assessment.

Keywords: CCP, Public Quantitative Disclosures, default waterfall, liquidity management, liquidity risk

1. Introduction

One of the main characteristics of the credit crisis was the opaqueness of the bilateral over-the-counter (OTC) derivatives market and in the inability of regulators and market participants to assess the extent of exposures, leading to a loss of confidence in the financial markets. The build-up of exposures amongst financial traders has placed Financial Market Infrastructures

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(FMIs) reform on top of the agenda for policy makers, as it became clear that FMIs are key to the resilience of the markets served and play a critical role in fostering financial stability.

An important change in the international framework for FMIs was the publication of the 'Principles for Financial Market Infrastructures' by the Committee on Payments and Market Infrastructures (CPMI) and the International Organization of Securities Commissions (IOSCO). This set of international standards for good practices in FMIs extend, harmonise, and strengthen the previous standards, covering a range of FMI operations, including, among other things, credit and liquidity management, default management, general business and operational risk management, with a focus on transparency (Committee on Payment and Settlement Systems - International Organization of Securities Commissions, 2012).

This paper is concerned with Central Clearing Counterparties (CCPs), also called clearing houses, the FMIs that facilitate post-trade settlement and clearing of financial transactions, including OTC derivatives. The centrally cleared market has grown in size since the global financial crisis. At the global level, the percentage of notional amounts outstanding of interest rate and credit derivatives which are centrally cleared has increased from approximately 27% to over 52% between 2009 and 2014 (Domanski et al., 2015). Regulatory reforms imposing mandatory clearing of certain types of interest rate and credit derivatives are likely to contribute to the continuation of this trend in the future (Rahman, 2015). In the European Union, certain categories of interest rate derivatives and Credit Default Swaps (CDS) are already subject to the clearing obligation, whereas the implementation of other categories is due to take place gradually until 2019.[1]

Against this background, the goal of this paper is to construct a dataset to study the Eu-

[1] The dates from which the clearing obligations take effect, and the categories of assets to which they apply are detailed in the Regulatory Technical Standards supplementing the European Market Infrastructure Regulation (Regulation (EU) No. 648/2012).

ropean CCP ecosystem using publicly available information. The contribution of the paper consists in documenting aspects of CCP operations, including the number of traders served by each CCP (clearing members), the asset classes cleared and the amounts of transactions, the default resources raised by the CCPs to protect themselves from counterparty credit risk, and the liquid resources maintained to settle payment obligations.

On the policy side, we provide an assessment of the extent to which the public disclosures required of CCPs by international standard-setting bodies and analysed in the paper allow an assessment of the risks posed by CCPs, for the clearing members and the financial system at large. We propose a number of policy actions aimed at improving the reliability of the data disclosed and their helpfulness for systemic risk assessment.

The paper is organised as follows. In the next Section we motivate our analysis. In Section 3, we describe the dataset. In section 4, we present stylised facts on the markets served by European CCPs and the resources held for credit risk management. Liquid resources are the focus of section 5. We conclude with a set of policy recommendations, including possible actions to improve the usefulness of the public data.

2. Motivation

In this Section, we provide a conceptual framework to guide the analysis. While our dataset covers several aspects of CCP operations, we focus on the following concepts. First, we review general characteristics of the member base: number of members by CCP, proportion of domestic and foreign members, and memberships in multiple CCPs. Second, we provide an overview of markets served, and whether and when CCPs segregate default funds, by asset class or ET/OTC. The size of market segments by transaction volume and the amount of resources available for default is also studied. Third, we investigate liquidity strategies of CCPs. By their very nature, CCPs hold considerable amounts of resources posted by members, and need to readily avail of liquid resources in the event a member defaults. We investigate liquidity management of CCPs, including the reinvestment of cash received from participants.

A clear view of member bases, in terms of size and degree of interconnectedness of participants, is crucial to understanding possible channels of contagion. CCPs replace a network of bilateral exposures with a new set of interconnections. Whereas risk management systems of CCPs are designed to insulate clearing members from other members' default, contagion may occur when a default event depletes the default fund, or in the case of default of the CCP (Wendt, 2015). Furthermore, the interconnectedness of member bases of different CCPs bears contagion risks. Under extreme market conditions, the default of a trader holding clearing memberships in several CCPs may transmit liquidity pressures to otherwise healthy clearing members or other market participants outside the CCP, for example by triggering the replenishment of default fund of several CCPs where another member is also active (Domanski et al., 2015; Roe, 2013).

Accordingly, the literature has studied the structure of member bases of CCPs from several points of view. Armakolla and Laurent (2017) focus on credit quality of CCP users. The paper provides an estimate of the deterioration in the creditworthiness of surviving clearing members after two average clearing members default. In the context of CCP interconnectedness through multiple memberships, the European Securities and Markets Authority considers the issue of common members in its first EU-wide stress test (European Securities and Markets Authority, 2016). On interconnections between market participants, Braithwaite (2015) highlights issues related to recent changes in the structure of member bases, focusing on the relationship between direct clearing members and their clients, which in this context are traders who use the CCP through a direct clearing member. Also, the geographical distribution of clearing members has received attention, in terms of the average share of domestic and foreign clearing participants, or the distribution of initial margin requirements by location of clearing members (Domanski et al., 2015; Rahman, 2015).

In addition to the number of clearing members, the size of CCPs by notional amounts determines netting efficiency and single point of failure risk. Duffie and Zhu (2011) show that, under some conditions, the highest degree of netting is obtained when a single, global CCP clears all asset classes. However, Pirrong (2014) and Gregory (2014) point out that netting redistributes risk, not necessarily reducing it. Netting benefits are reaped mostly by members with largest portfolios, and in case of default, netting redistributes losses at the expense of non-member creditors. Moreover, the benefits of multilateral netting from a higher concentration of the clearing market have to be weighed against the increased single point of failure risk associated with large CCPs (Cont and Kokholm, 2014).

The netting benefits of a CCP depend on its default management strategy, of pooling or segregating the asset classes cleared into a single or multiple default funds. Pooling many asset classes within one default fund has advantages and disadvantages. On the positive side are diversification of risk and margin efficiency. In the futures market, Gemmill (1994) shows that the benefits from diversification can be large; the size of benefits depends on the correlation between products cleared, which can be difficult to predict in case of market disruptions. On the negative side, mutualisation of losses across asset classes results in a subsidy to riskier asset classes, which could mean moral hazard issues and increased risk-taking by clearing members (Gregory, 2014).

Moreover, the size of a CCP may determine its substitutability. If a CCP is in resolution, or in any other situation where members can no longer clear at a CCP, the transfer of transactions to another CCP can be challenging and lead to legal disputes. Although the European Market Infrastructure Regulation (EMIR) provides certain requirements for CCP recovery frameworks the EU, there are still differences between EU member states in insolvency laws and tax regimes (see for example Braithwaite and Murphy (2016)). Moreover, the initial clearing agreement would have to be amended (Duffie, 2014). In the case of a large CCP, substitutability issues may lead to a systemic event.

In addition to legal issues, transferring all positions from a large CCP may give rise to technical difficulties. If only that CCP is in the market for a specific product, it may take time for new entrants to acquire product-specific know-how, set up the necessary internal structures, and implement risk management strategies. Should more than one CCP be in the market, clearing members can obtain membership at another CCP. On the one side, differences in membership criteria and possibly higher costs may prevent some clearing members from continuing to centrally clear that product. On the other side, the addition of new clearing members necessitates documentation and due diligence work by the CCPs taking over the market share. If the size of the exiting CCP is large, the remaining ones may be put under significant resource constraints, and clearing members may temporarily lose access to central clearing for certain products.

The last aspect investigated in this study is liquidity management. The matched book of a CCP means that if a member defaults, liquid resources are needed to meet the obligations towards the other leg of the contract (Gregory, 2014; Hughes and Manning, 2015). When liquidating the initial margin of the defaulted member, CCPs face liquidation risk. For this reason, CCPs apply haircuts to non-cash collateral posted by members, to account for possible adverse price movements at the time of liquidation. However, CCPs also re-invest cash collateral, and retain exposure to credit and liquidity risk from such investments (Committee on Payment and Settlement Systems - International Organization of Securities Commissions, 2004).[2] The risk that re-investment poses is similar to margin wrong-way risk: if the price of

[2]The only resource available to CCPs to cover losses stemming from investment (non-default losses) is

the asset used as collateral is positively correlated with the creditworthiness of the member posting it, the value of initial margin tends to decrease when the member defaults. Similarly, re-investment wrong-way risk occurs if the price of the securities purchased by the CCP tends to drop when they need to be liquidated, that is when the member whose cash has been invested defaults.

A fall in price of the reinvested instrument may be due to credit or liquidity risk, for example if the CCP buys corporate bonds of the clearing member from which it received cash collateral. When the clearing member defaults, the bond price will reflect the decrease in creditworthiness; if bonds are illiquid, liquidation will further decrease the price. To avoid this, EMIR requires CCPs to invest participants' cash in assets which remain liquid even in extreme market conditions.

Margin wrong-way risk also occurs if the risk premium applied to instruments held as collateral increase under stressed market conditions. The European sovereign debt crisis showed that government bond prices are more sensitive to weak fundamentals, including domestic financial sector health, when uncertainty in global financial markets is high (Bianchi, 2016). In section 5, we will show that CCPs invest non-negligible amounts in sovereign bonds, domestic bonds in particular. If risk premia were to spike again when the financial sector is in stress, CCPs may incur losses. Whereas the Banking Union and the European Stability Mechanism were developed to limit the negative feedback between banks and sovereigns, their effectiveness under stress has not yet been tested.

3. Data

The main source of our data is the Public Quantitative Disclosure (PQD) framework for CCPs. The PQD is the result of the application of Principle 23 of the 'Principles for Finan-

own capital (Rehlon and Nixon, 2013).

cial Market Infrastructures'.[3] In accordance with the PQD framework, CCPs are encouraged to publish a set of standardised data intended to enable stakeholders to compare risk control strategies, understand the risks associated with the CCP, assess the systemic importance of the CCP and its impact on systemic risk, and understand the risks involved in becoming a member (Committee on Payments and Market Infrastructures - International Organization of Securities Commissions, 2015).

To our knowledge, this is the first paper to have assembled and analysed the information in the PQDs for European CCPs. One of our contributions is highlighting a number of issues encountered while studying the PQD data and suggesting possible improvements to enhance CCP transparency and extend the scope of analyses which can be done using this source of data.

The PQD data is provided quarterly and contains information on several aspects of CCP operations. The variables are grouped according to the principles set out in the PFMI: Credit risk (Principle 4), Collateral (Principle 5), Margin (Principle 6), Liquidity risk (Principle 7), Exchange of value settlement systems (Principle 12), Default rules and procedures (Principle 13), Segregation and portability (Principle 14), General business risk (Principle 15), Custody and investment risks (Principle 16), Operational risk (Principle 17), Access and participation requirements (Principle 18), Tiered participation arrangements (Principle 19), FMI links (Principle 20), and Disclosure of rules, key procedures, and market data (Principle 23). In this paper, we analyse a subset of the disclosure data and present a high-level picture of the actors in the clearing landscape, including size and aspects of their risk management strategies. In Appendix B, a summary of the variables used and the modifications made to

[3] Principle 23 of the PFMI states that '*an FMI should have clear and comprehensive rules and procedures and should provide sufficient information to enable participants to have an accurate understanding of the risks, fees, and other material costs they incur by participating in the financial market infrastructure. All relevant rules and key procedures should be publicly disclosed*' (Committee on Payment and Settlement Systems - International Organization of Securities Commissions (2012), p. 121).

the original disclosures, implemented to correct mistakes and ensure consistency, is provided.

The disclosure data is provided by CCPs at three levels: CCP level, when the data refers to the whole CCP; default fund level, when the data refers to products covered by a segregated default fund; and clearing service level when there are clearing services that are not delimited by a segregated default fund (for instance, when there is more than one clearing service covered by a default fund). If a CCP uses an integrated default fund covering all products cleared, CCP and default fund levels coincide. If a default fund covers all products cleared in a clearing service, default fund and clearing service levels coincide.[4]

Table A.1 lists the CCPs included in the sample and the respective country of domicile. Three additional European CCPs have published PQD data following a template different to the one used by CCPs in Table A.1 and were excluded. Future work aims at filling the gap. PQD data is available since 1^{st} January 2016, and has been disclosed with a three-month lag. At the time of writing (September 2016), information for three quarters is available, ending on 30^{th} September 2015, 31^{st} December 2015, and 31^{st} March 2016.

In addition, we extend the dataset with publicly available information on clearing members and contracts cleared. The member lists were retrieved from CCPs' websites and matched with information on domestic or foreign residency of the members. We also gathered the list of products cleared in each CCP, when relevant by segregated default fund.

[4] There is a slight difference between the provisions set out in Committee on Payments and Market Infrastructures - International Organization of Securities Commissions (2015) and the scheme CCPs follow in the excel templates used for reporting, in terms of names for the reported level. The template has been developed in a collaboration between associations of CCPs (the European Association of CCP Clearing Houses (EACH) and the Global Association of Central Counterparties (CCP12)) to ensure consistency and standardisation of reporting. The difference has caused some confusion regarding the level reported, thus we have homogenised the naming of the statistical units' level using the definition noted above: CCP level, default fund level, and clearing service level. Information available on the websites of CCPs has been used to identify the correct level reported for each CCP, when the classification of levels did not comply with this definition.

4. The European CCP ecosystem

In this Section, we show stylised facts from our dataset, including size of member bases and degree of interconnectedness through common memberships, size of CCPs by volume of transactions, and size and composition of default resources. Table A.1 defines the abbreviations used for the names of the CCPs in our sample.

4.1. CCP member bases and interconnectedness

The PQD data provide aggregated information on clearing members at the default fund level, limited to the number of members by type of membership held, type of institution (bank, central bank, CCP, etc.), and residency (foreign or domestic). We use the member lists provided by CCPs on their websites to give a more detailed view of the the member bases and the degree of interconnectedness at the CCP level.

Table A.2 shows the total number of clearing members, the proportion of domestic and foreign participants, and the average number of clearing memberships per individual participant. Nasdaq OMX has the largest participation with 247 clearing members, followed by Eurex Clearing with 192 and LCH.Clearnet LTD with 153 members. ICE Clear NL serves three members, which are financial institutions with large trading activity, mostly conducted on behalf of their clients. The CCPs with the largest proportions of domestic members are KDPW, BME Clearing, and CC&G.

The shares of domestic and foreign participants in Table A.2 do not provide a complete picture of the international relevance of CCPs as they do not capture interoperability agreements.[5] For instance, the international relevance of CC&G according to Table A.2 may be underestimated by not accounting for the interoperability agreement with LCH.Clearnet SA.

[5]Interoperability arrangements are links between CCPs whereby members of each CCP can clear trades with members of the other CCP without becoming a member of the other CCP.

CC&G and LCH.Clearnet SA have an interoperability agreement enabling members from both CCPs to enter into repo transactions with each other directly, without being a clearing member at the other CCP. Moreover, the residency of clearing members' clients is not represented in the Table. In the case of ICE Clear NL, the residence of clearing members carries little information on the residence of the ultimate counterparties of the trades cleared. This can be seen from the proportion of initial margin posted by the clients of ICE Clear NL, which is 93.6 % of total initial margin. Whereas two of the three clearing members are domestic, the same proportion may not apply to their clients.

In addition to the size of the member base, it is instructive to consider the number of CCPs in which a single member participates. This is important to understand the potential for contemporaneous stress in multiple CCPs, driven by the default of an interconnected member. Consistent with the definition of interconnectedness applied by European Securities and Markets Authority (2016), in Figure A.2 we show, for each CCP, the average number of memberships.[6]

ICE Clear NL has the highest degree of interconnectedness per clearing participant. One of the clearing members of ICE Clear NL has 11 clearing memberships in the 12 CCPs we consider, which is the largest number of multiple memberships per member in our sample. This is a financial institution specialised in client clearing services. By being a member in several CCPs, it offers a wide set of clearing opportunities. In contrast, the members of KDPW, in average, clear only at KDPW. Given the high proportion of domestic members in this CCP, its degree of interconnectedness with the rest of the European system is likely to be small.

[6]The average does not consider group level affiliation of individual clearing members. If this were to be considered, the average number of memberships would be higher.

Overall, our sample comprises 726 clearing members. Of these, 564 entities clear at only one CCP, representing about 78 % of the overall number of clearing members. This is in line with the findings of European Securities and Markets Authority (2016) EU-wide stress test, reporting that 85 % of the more than 900 members of the 17 CCPs considered clear at only one CCP. European Securities and Markets Authority (2016) also reports that 11 individual clearing participants clear at 10 or more CCPs, whereas in our sample we identify one.

Interconnectedness in the CCP ecosystem is of primary concern (Wendt, 2015; Yellen, 2013), as risk is concentrated in the clearing structures and the default of highly interconnected G-SIB members may pose a threat to CCP resilience. To fully understand the structure and consequences of interconnectedness in the CCP ecosystem, the exposure each individual participant has at each CCP should be considered together with its activities in the bilateral markets.

4.2. Products cleared and default fund segregation

Tables A.4 to A.9 list, for each default fund, the asset classes covered, the types of contract, and the underlying assets. Being at the default fund level, the Tables convey information on the degree of mutualisation across asset classes. We grouped the default funds together on the basis of similarities in the composition of asset classes cleared. A residual group contains default funds covering a wider range of asset classes.

Five CCPs in our sample have a single default fund covering all products cleared. EuroCCP and ICE Clear NL clear equity, derivative and cash products, LME clears commodity derivatives traded in the London Metal Exchange, and CCP.A and Eurex Clearing clear a mix of asset classes, including equity and bond derivatives, interest rate derivatives, and other securities. The extent of mutualisation within these CCPs varies, owing to differing degrees of heterogeneity in the type of transactions cleared and to different loss allocation rules.

Given a mixed default fund, loss allocation rules can mitigate mutualisation across asset classes. Generally, pooling different asset classes in the same default fund means that the mutualisation of losses occurs regardless of the markets in which the defaulting clearing member is active. In the case of single default fund, clearing members trading in less risky markets are exposed to losses caused by riskier clearing members. To avoid this, Eurex Clearing clusters the trades cleared according to the risk characteristics of the underlying products (Liquidation Groups). Each Liquidation Group is assigned to a segment of the default fund. Losses arising from trades in each Liquidation Group are distributed first among the participants active in the relevant Liquidation Group (Eurex Clearing, 2014).

The remaining eight CCPs in our sample limit mutualisation within segregated segments, defined by the asset class cleared. Four CCPs established default funds specific to fixed income products (Table A.4). Of these, BME has a segment exclusively for repurchase agreements (repo), whereas CC&G, LCH.Clearnet SA and LCH.Clearnet LTD cover both cash bonds and repos within the same default fund. LCH.Clearnet SA also has a separate default fund for tri-party repos (€CG plus).

In the equities market, four CCPs have a segregated default fund, which in several cases also covers certain types of bond transactions.[7] The origin of the underlying stock relates to the residency of the CCP in two cases: BME clears mostly ET Spanish equity derivatives and futures on goverment bonds; CC&G clears cash equities and ET equity derivatives in the Italian market. Other CCPs have more geographically sparse operations: LCH.Clearnet SA covers stock issued in several European countries, including ET equities and bonds, and transactions traded in a multilateral trading facility.[8] LCH.Clearnet LTD covers bonds and equity products issued in several countries (Table A.5).

[7] LCH.Clearnet SA also covers ET commodity derivatives in this default fund.

[8] Multilateral trading facilities are non-exchange trading venues operated by financial firms in order to facilitate retail trades.

As shown in Table A.6, six default funds cover the energy and commodity markets. Futures and options, often traded in regulated markets, are the financial product typically cleared in this segment.

Only two CCPs have a segregated segment for interest rate derivatives (Table A.7). BME started a new segment in November 2015 covering the interest rate derivatives for which the EU clearing obligation entered into force in June 2016.[9] LCH.Clearnet LTD holds two segments in this market, segregating ET from OTC interest rate derivatives.

In Table A.8, only two CCPs offer segregated default funds for CDS: ICE Clear EU and LCH.Clearnet SA. The clearing obligation for this type of products is not in place at the time of writing (September 2016), but will take effect gradually for different categories of CDS between February 2017 and May 2019.

4.3. Size of Segments and Waterfalls

Having described the products covered in each segment, we now look at CCP size and waterfall size in each segment (Figures A.1 to A.6). Size is measured by average daily transactions cleared, in nominal (or principal) amounts. All contracts covered by a default fund are summed up, regardless of the product type. As segments often contain a mix of different products, this is a rough measure of CCP activity. Yet, with this caveat in mind and considering the description of the products covered by the default funds in our sample, this measure allows comparing the activities of CCPs in a market segment.

The juxtaposition of notional amounts and waterfall in Figures A.1 to A.6 is not meant to provide an assessment of risk management practices of CCPs. In fact, the transactions

[9] Other types of interest rate derivatives will be subject to mandatory clearing in the future; the clearing obligation for last category will take effect in 2019.

cleared may increase without increasing exposures. Conversely, the same amount of transactions for the same product may be associated with different levels of exposure, depending on the time to maturity of the contracts and the frequency of trades. For instance, a two-day contract is less risky than a two-year contract with the same notional amount; a two-year contract traded out after two days is less risky than an identical contract kept until maturity. The figures are intended to show the size of the markets served by CCPs in each segment and the corresponding default resources.

The connected scatter plots in Figures A.1 to A.6 show average daily volumes of OTC products and ET derivatives at the default fund level (right-hand-side scale). The stacked bars show the amount and composition of the default waterfall resources: total initial margin required, own CCP capital, and default fund, recorded at the end of the quarter (left-hand-side scale).

The PQD data on initial margin and default fund contributions reflect exposures at different points in time. Initial margin is calculated at least daily, so it tracks exposures relatively well, while the default fund is sized monthly (or at even lower frequencies). Rather than assessing whether these resources are appropriate, we use them as a measure of exposure. By comparing default waterfall resources and CCP size, it is then possible to relate the evolution of the cleared market with the evolution of exposures.

For LCH.Clearnet SA and CC&G, average daily transactions cleared in the fixed income segment increased between the third quarter of 2015 and the first quarter of 2016, and so did exposures (Figure A.1). For LCH.Clearnet LTD and BME Clearing, the data shows a decrease in both transactions and exposures in the same period. Cash bond and repo transactions cleared via LCH.Clearnet LTD's 'Fixed Income' service dropped at the same rate, by around 12 % between the third and the fourth quarter of 2015, and increased by around 6.7 %

in the following quarter. More recent monthly data published by LCH.Clearnet LTD shows that the drop in repo transactions has been more than recovered by June 2016.[10] On the contrary, in the case of BME Clearing, the timing of the PQD framework somewhat hides the plunge in cleared repo transactions that occurred after June 2015, with average daily transactions falling by nearly 30 % monthly in July 2015 and 50 % year-on-year in June 2016.[11]

The composition of the waterfall resources for fixed income products is related to the type of transactions. CCPs clearing traditional repurchase agreements only, such as BME Clearing, or in large proportions, such as LCH.Clearnet SA ('Bonds and Repos'), have a low percentage of default fund in the total waterfall compared to segments where the share of cash bonds cleared is higher.

Figure A.2 charts the evolution of volumes and exposures for default funds covering mostly equity transactions, cash and derivatives. Only CC&G, ICE Clear NL, and EuroCCP report notional amounts in this segment. For four CCPs, exposures decreased in the period considered. For LCH.Clearnet LTD's 'Equities' and EuroCCP, exposures increased between the third quarter of 2015 and the first quarter of 2016, although in both cases a significant decrease was observed in the preceding quarter. The temporary drop in waterfall resources is due to a decrease, and a subsequent increase, in initial margin. Whereas for LCH.Clearnet LTD's 'Equities' the initial relative size of default fund is restored in the last quarter, for EuroCCP the default fund increases more than proportionally to 25 % of the waterfall resources. In the most recent quarter, the weight of the default fund in total waterfall ranges between 3 % for BME Clearing's 'Financial derivatives' and 39 % at ICE Clear NL. Segments with a larger proportion of equities cleared have a larger proportion of the default fund.

[10](see `http://www.lch.com/asset-classes/repoclear/volumes`)

[11](see `http://www.bmeclearing.es/ing/aspx/MeffREPO/EstadisticasDiarias.aspx`)

In the Energy and Commodities segment, depicted in Figure A.3, transaction volumes reported by Nasdaq OMX, CC&G, and LME have decreased in the observed period. Default waterfalls have shrunk in all segments with the exception of Nasdaq OMX' 'Commodities' and BME Clearing's 'Power' segments. BME Clearing nearly doubled its waterfall resources in this segment, in stark contrast to the decrease by 80 % in default waterfall resources observed for LCH.Clearnet LTD. Excluding CC&G, the composition of the waterfall in this segment is relatively homogeneous: the default fund represents between 4 % and 12 % of the total. For CC&G, the default fund constitutes more than half of the default waterfall resources in all quarters.

Five CCPs in our sample offer clearing services for interest rate derivatives: LCH.Clearnet LTD, BME Clearing, KDPW, Nasdaq OMX, and Eurex Clearing. The latter three CCPs do not segregate a specific default fund for this product. LCH.Clearnet LTD has two segregated default funds, for ET and OTC derivatives, respectively. BME Clearing is a new entrant, having started a new default fund in November 2015. The segment started to be used effectively in the first quarter of 2016. Monthly notional volumes increased from 20 million euro in January to 1,623 million euro in March.[12] In Figure A.4, the process of implementation of the waterfall for the new segment is visible. As the size of a default fund depends on exposures, when members do not yet have open positions, the calibration of a new default fund depends on estimated clearing activity.

LCH.Clearnet LTD's 'OTC interest rates' transactions increased in the three quarters (Figure A.4). The sample period does not include the start of the clearing obligation. Consequently, the complete adjustment of the market will be visible from the PQD when data when the

[12] Statistics on monthly notional volumes are available at `http://www.bmeclearing.es/ing/aspx/MEFFPower/Comunicados.aspx?tipo=3427`

third quarter of 2016 will be available.

Only ICE Clear Europe and LCH.Clearnet SA are active in the cleared OTC CDS market (Figure A.5). Volumes increased between the first and the last quarter in the sample for ICE Clear Europewhile default waterfall size decreased slightly. In contrast, volumes decreased for LCH.Clearnet SA while the waterfall increased dramatically. Notional amounts for LCH.Clearnet SA's 'OTC CDS' service increased four-fold in the first quarter of the sample, dropping ten-fold in the following quarter. Without knowledge of the characteristics of the specific contracts, it is difficult to determine the descriptive ability of these numbers. The percentage of default fund in total waterfall oscillates between 12 % and 14 % for ICE Clear Europe, and between 31 % and 38 % for LCH.Clearnet SA.

In Figure A.6, we show all segments that do not have a comparable product mix to other CCPs in the sample, along with segments (or CCPs) covering many asset classes in the same default fund.[13] Eurex Clearing stands out as the largest segment in terms of waterfall amounts in this group, as well as compared to any other segment. The total waterfall of Eurex Clearing is on a decreasing path, from 50 billion euro in the third quarter 2015 to just above 40 billion euro in the first quarter of 2016. ICE Clear Europe's 'Futures and Options' segment has the second largest waterfall. The product mix cleared via ICE Clear Europe's 'Futures and Options' is more homogeneous than than that of Eurex Clearing. Nasdaq OMX' Seafood' is the third largest segment in the group as per waterfall amounts, clearing derivatives on salmon.

5. Liquidity and liquidation risk

In this Section, we investigate the liquidity management of the default waterfall resources held by CCPs to withstand member defaults. We first consider the amount of liquid resources

[13] CCP.A starts reporting PQD in the first quarter of 2016.

CCPs hold relative to the total resources at their disposal. Then, we explore the liquidity management of reinvested participant cash and the composition of initial margin and default funds.

5.1. Qualifying liquid resources

According to EMIR, CCPs have to hold enough qualifying liquid resources (QLR) to withstand the default of any two clearing members, at the CCP level. Whereas the segregation of default funds is implemented for solvency reasons, to isolate members clearing one asset class from members clearing in a different asset class, there is no similar rationale to segregate liquidity at the default fund level. It is therefore appropriate to consider the amount of liquid resources CCPs hold relative to the total resources at their disposal, across all default funds.

Table A.3 reports the total amount of QLR held in any currency, total amount of default resources across all segments, and the ratio between the two. A ratio greater than 1 means that the amount of qualifying liquid resources is greater than the pre-funded default resources.[14] While looking at QLR relative to the overall default resources is informative as to the potential availability of default resources in case of a default, the actual liquidity needs will depend on the size of the exposure vis-à-vis the members in default. All else being equal, a CCP where exposure is concentrated in a small number of members will need more liquid resources than a CCP where exposures are dispersed across the members. To address this issue, in Table A.3 we also show the percentage of initial margin posted by the largest 5 clearing members.[15]

The ratio of QLR over default resources tends to be higher in CCPs with more concentrated exposures; the correlation is 0.5. For example, the QLR ratio of Eurex Clearing is amongst

[14] The liquid resources could also be used by the CCP to pay variation margins when a member delays on its obligation. The default resources include both those provided by clearing members (initial margin and default fund contributions) and by the CCP itself (Skin-in-the-game).

[15] The PQDs contain data on concentration in the largest 5 and largest 10 clearing members.

the lowest, but the largest 5 members account for only 39 % of total initial margin. The QLR ratio of EuroCCP is higher, and so is the concentration of initial margin. This is to be expected: were concentration of exposures is high, a larger portion of default resources have to be liquidated when large members default.

To complete the picture, the table also reports total QLR and total default resources. When a default event depletes the available QLR, the CCP will need to raise additional liquid resources. The size of the CCP's exposure then determines the additional liquidity needs. Whereas the ability of CCPs to raise funds in stressed market conditions depends on the resilience of liquidity providers and the CCP's access to central bank liquidity, the level of emergency liquidity needs is a function of exposures.

Two CCPs with similar QLR and concentration ratios are Nasdaq OMX and LCH.Clearnet LTD. If the default of the five largest clearing members depletes the QLRs of both CCPs, then assuming the same percentage of exposure remains uncovered, the liquidity crisis of LCH.Clearnet LTD will be more severe. This is because the exposure of LCH.Clearnet LTD is 17 times the exposure of Nasdaq OMX.

The discussion so far assumes that QLR are homogeneously liquid resources. However, not all types of qualifying liquid resources share the same degree of liquidity. For instance, central bank deposits are the only instrument to be virtually 100 per cent reliable in stressed market conditions. Commercial bank deposits, committed lines of credit and '*Highly marketable collateral held in custody and investments that are readily available and convertible into cash with prearranged and highly reliable funding arrangements even in extreme but plausible market conditions*' (European Union, 2012), on the other hand, are liquid insofar as the liquidity provider is able to fulfil its obligations when the resources are needed.[16]

[16] Liquidity providers of CCPs are often clearing members; since initial margin and default resources are

Figure A.7 shows the composition of QLR. Eight CCPs hold central bank deposits; three of which in amounts larger than half the total waterfall resources. Overall, there is high reliance on commercial bank secured deposits, which include reverse repo. Also important is the reliance on highly marketable collateral and secured committed lines of credit and, to a smaller extent, unsecured committed lines of credit. Unsecured deposits at commercial banks and other QLRs are less common liquidity instruments.

In summary, in this section we exposed the information on the liquid resources of CCPs which is available from the PQDs. This is a valuable source of information which allowed us to give a bird-eye view of the liquid resources of CCPs. In the next section, we zoom in the disclosures in order to assess whether it is possible to use the information provided to draw conclusions on liquidity risk.

5.2. Reinvestment of participant cash

To cover margin or default fund requirements, participants can provide eligible securities or cash to the CCP, in accordance with collateral rules specific to each CCP. Typically, CCPs require members to post a percentage of collateral in cash and restrict the proportions of specific securities in the collateral pool. CCPs are allowed to reinvest this cash in highly liquid resources. According to EMIR Article §47, a '*CCP shall invest its financial resources only in cash or in highly liquid financial instruments with minimal market and credit risk. A CCP's investments shall be capable of being liquidated rapidly with minimal adverse price effect*' (European Union (2012), p. 39). This Section describes how CCPs manage the cash received from participants.

Figure A.8 shows that five CCPs deposit the majority or all of participants' cash in central

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needed when clearing members are under stress, it is possible that the liquidity providers are not able to meet their obligations towards the CCP when needed.

banks. Five other CCPs deposit the majority or all cash in other financial institutions. The remaining two CCPs have a mixed reinvestment policy, whereby a significant proportion of the cash is invested in securities. Focusing on the first quarter of 2016, CC&G invested 66 % of participants' cash in securities. Of this, 48 % were invested in Italian government bonds (5.4 billion euro), 40 % in foreign government bonds (4.5 billion euro), and 12 % in agency or municipal bonds (1.3 billion euro). Nasdaq OMX reinvested a third of participants' cash in government bonds (the equivalent of 1 billion euro), a third in central bank deposits, and the remaining third in commercial bank deposits and other securities. Other CCPs with non-negligible investments in government bonds are LCH.Clearnet LTD, ICE Clear Europe, LCH.Clearnet SA, LME, and KDPW.

While for securities received by CCPs directly from clearing members, haircuts are applied to account for liquidation risk, securities bought by a CCP with members' cash do not have a haircut applied to them, even though they are often the same securities. However, CCPs have 'prearranged and highly reliable funding arrangements' to liquidate collateral even in extreme but plausible market conditions. We now turn to comparing the amount of reinvested securities with the amount of highly reliable funding arrangements that are available to convert securities into cash even in extreme but plausible market conditions.

Figure A.9 shows securities holdings of CCPs. The first two bars illustrate securities held as initial margin and default fund, respectively. This includes both securities posted by clearing members (post haircut) and securities purchased by the CCP with members' cash posted as initial margin and default fund, respectively.[17] The third bar is participants' reinvested cash, for which the PQD does not provide the allocation along the waterfall. The fourth bar is 'highly marketable collateral held in custody and investments that are readily available

[17] Bond holdings are based on concepts 4.3 and 6.2 of the PQD, which require CCPs to report the composition of prefunded default resources and initial margin held, as opposed to posted.

and convertible into cash with prearranged and highly reliable funding arrangements even in extreme but plausible market conditions' (European Union, 2012).

According to PQD standards, the third bar should be *at most* equal to the sum of the first two bars, since securities held as initial margin or default fund include reinvested cash. This is not the case for CC&G; this CCP may not be following PQD standards closely. Cross-checking PQD data with information from the collateral rules of CC&G, we concluded that initial margin composition is reported by CC&G as it is posted by members, rather than held by CC&G. For the other CCPs, figures are consistent with the other information available and in what follows we will assume they follow PQD standards precisely.

Comparing the third and fourth bars in Figure A.9 allows us to determine whether the highly reliable funding arrangements are sufficient to liquidate the securities in which the CCP reinvested members' cash.[18] This is not the case for CC&G and KDPW: if these CCPs need to liquidate all the securities bought with members' cash, they may face the risk of selling at market price.

Furthermore, the member bases of CC&G and KDPW are mostly domestic, and both invest significant amounts of the cash received in securities issued by the domestic public sector. This means that there may be a positive correlation between the price of collateral and the default probabilities of clearing members, if for example there is a public guarantee on bank deposits. Therefore, if these CCPs have to sell domestic government bonds at market price when a domestic member defaults, they will be exposed to margin wrong-way risk. Future data requirements, for instance on the arrangements in place with the liquidity providers, could help shed light on the magnitude of such risk.

[18] While it is not possible to ascertain whether the contracts to which the QLR item refers apply to the securities reinvested in by the CCP, it is still true that, if the fourth bar is lower than the third, there are not enough prearranged and highly reliable contracts to cover all reinvested cash.

To sum up, the PQDs provide useful data to understand liquidity management of CCPs. However, we believe this is not sufficient to appropriately assess the adequacy of liquidity strategies.

5.3. Composition of initial margin and defaults funds

In order to complete the picture describing liquidity management, Figures A.10 and A.11 show the composition of initial margin and default fund held. As is often the case with the PQD, some CCPs do not respect requirements fully and report at a lower level of detail, which makes comparison difficult.[19]

The way in which CCPs can hold initial margin and default fund resources is regulated in EMIR and EMIR related technical standards. Every CCP sets rules on the specific assets and currencies that clearing members can post as collateral. CCPs also impose restrictions on the composition of posted collateral, such as concentration limits, rules on the proportion of cash, exclusion of own assets, and the like. CCPs also decide the haircut to apply to each specific asset. For a comparison of collateral eligibility frameworks across asset classes, see European Central Bank (2013) and European Central Bank (2014).

Among the different ways a CCP can invest resources, central bank cash deposits are the safest way to deposit waterfall resources and represent the most liquid portion. Investing the waterfall resources in high-quality securities fosters diversification and may generate a modest return on investment without significant risks (Gregory, 2014). Depositing cash with a commercial bank can be concluded via secured and unsecured deposits.

As shown in Figure A.10, most CCPs in our sample hold a large proportion of initial margin

[19] The composition of initial margin should be reported for each currency in which the margin is posted. The composition of default resources should be reported at the default fund level.

as a mix of central bank deposits, commercial banks deposits, and sovereign bonds. Holdings of initial margin in more risky assets, such as corporate bonds, represents a lower, although in some cases non-negligible, portion.

Figure A.11 shows that the resources in the default fund are held in more liquid assets than initial margin. This is due to the stressed market conditions under which the default fund is typically tapped.

6. Conclusion

After the global financial crisis, central clearing has been placed at the heart of the new financial regulatory framework. The introduction of mandatory clearing has reinforced the recent trend followed by market participants to clear financial trades through CCPs. At the same time, risk management strategies of CCPs have been strengthened by the application of the PFMI.

An important aspect of the PMFI is the importance assigned to transparency: '*Transparency helps ensure that relevant information is provided to an FMIs participants, authorities, and the public to inform sound decision making and foster confidence.*' (see Committee on Payment and Settlement Systems - International Organization of Securities Commissions (2012), p.121). The public quantitative disclosures (PQD) for central counterparties are the application of this principle to CCPs; the disclosures should enable all interested parties to compare risk controls and to have a clear, full and accurate understanding of the risks associated with CCPs, to assess CCPs systemic relevance and the impact on systemic risk (Committee on Payments and Market Infrastructures - International Organization of Securities Commissions, 2015).

The contribution of this paper is twofold. First, we assemble a dataset which comprises the public quantitative disclosures as well as other publicly available information. Whereas the disclosures are meant to follow standards that ensure comparability, the data is provided in different formats, which made compiling the dataset non-trivial. Moreover, the raw data was not always comparable; we used further publicly available information to fill the gaps and ensure consistency.

Second, we provide stylised facts on the European CCP ecosystem. European CCPs are heterogeneous in terms of number of clearing members, type of assets cleared and size of markets served. Moreover, CCPs have differing risk management strategies. This is reflected in the size and structure of the default resources and the size and structure of the liquid resources. In our analysis, we encountered a number of issues which reduce the usefulness of the data from a risk assessment perspective.

Our analysis shows that the PQD data can be used to monitor the evolution of the CCP landscape across various aspects, including risk management strategies - a very important step towards full understanding of the central clearing environment. However, data quality is not consistent across CCPs, and data are not provided at the high frequency needed to construct indicators of systemic risk. These would also need to account for differences in margining models and stress test methodologies, which are only marginally covered. In the remainder of this section, we provide a number of suggestions which could help improve the usefulness of PQD data.

The PQD framework is voluntarily followed by CCPs. There is no legal requirement for CCPs in the EU to provide this data. Therefore, there are CCPs not reporting, or publishing data in different formats to the template agreed on by the majority of EU CCPs. Regulatory authorities may wish to make the provision of PQD data mandatory and fully standardised for all CCPs.

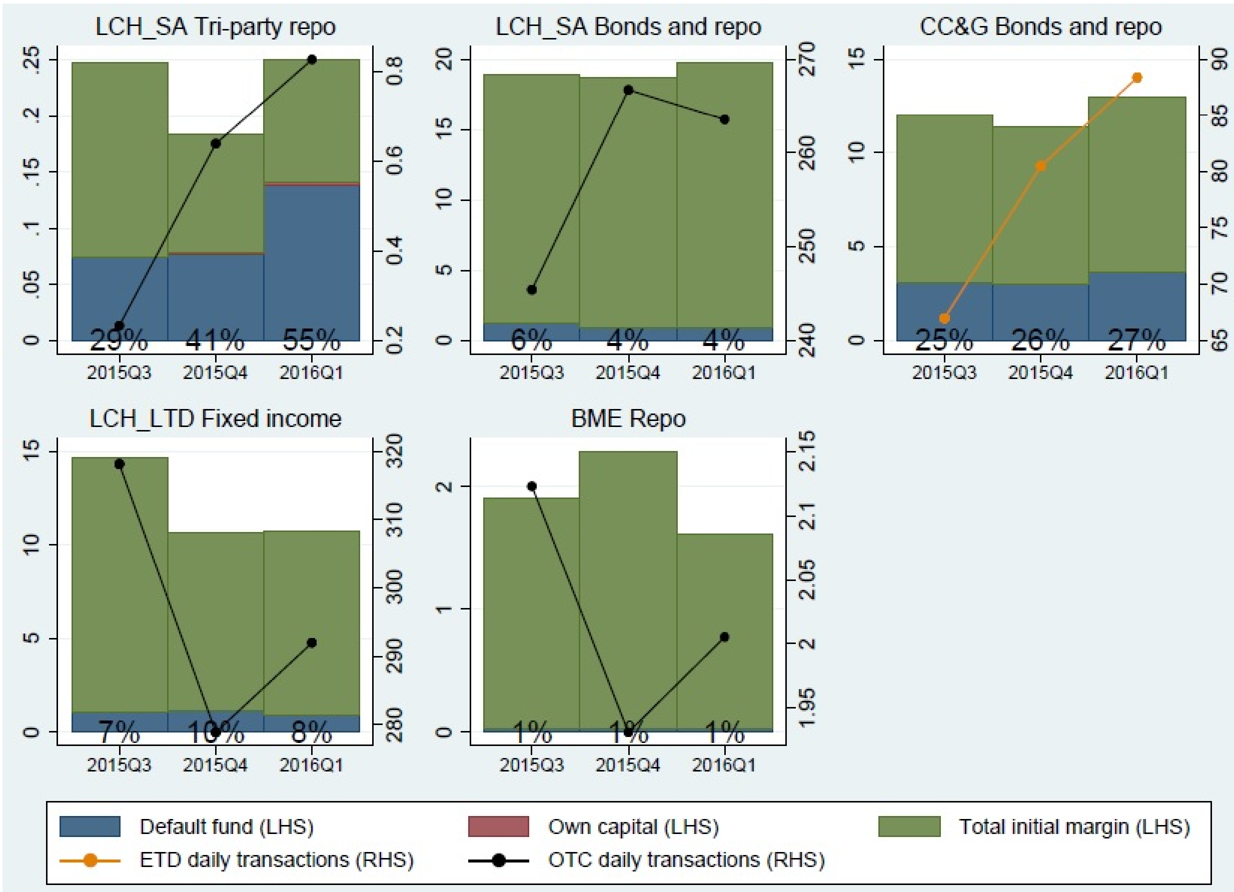
Besides the absence of a legal requirement to publish PQD data, and possibly as a consequence of the lack of legal binding, no process of validation is in place to ensure that the figures reported are correct, in terms of interpretation of the requirements and truthfulness of the reporting. Competent authorities mandated with CCP oversight could perform data quality checks and require CCPs to correct possible mistakes.

The PQD data is currently provided at quarterly frequency and with a three-month lag. In order for analyses on systemic risk to be possible, and to create early warning indicators for CCP distress, the provision of PQD data on a monthly basis could be considered. A one-month lag in reporting may be sufficient to increase the signalling properties of indicators based on PQD.

To conclude, the public quantitative disclosures for CCP are a welcome first step towards a clear, full and accurate description of the operations of CCPs. Further work is needed to enable stakeholders to fully understand the risks they pose.

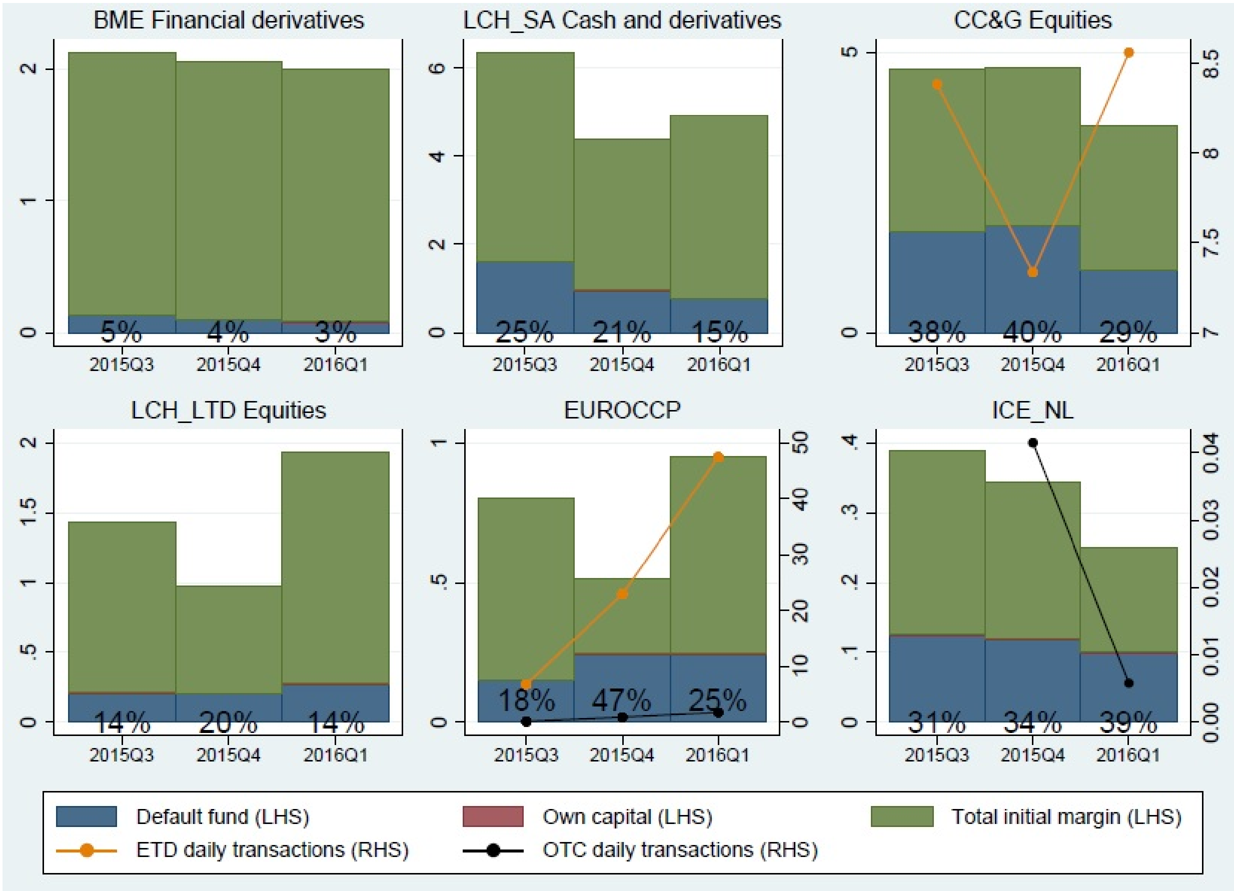
AppendixA. Tables and Figures

Figure A.1: Fixed Income



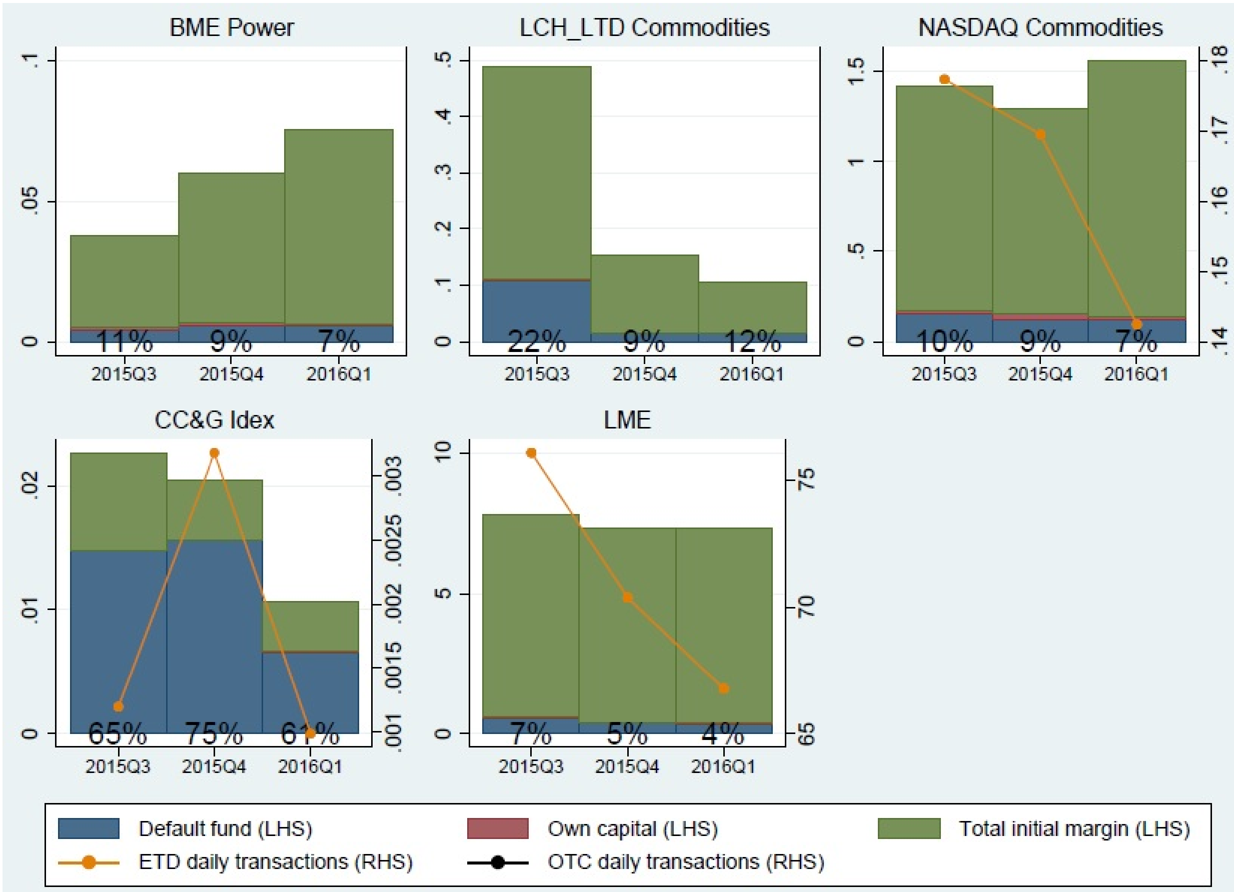
Note: Transaction volumes are notional (or principal) amounts, right-hand side scale (RHS), billion euro. Initial margin, default fund and own capital are also in billion euro, left-hand side scale. Percentages are share of the default fund in total waterfall. CC&G does not provide split by ET and OTC transactions.

Figure A.2: Average daily volumes and waterfall. Equity segment.



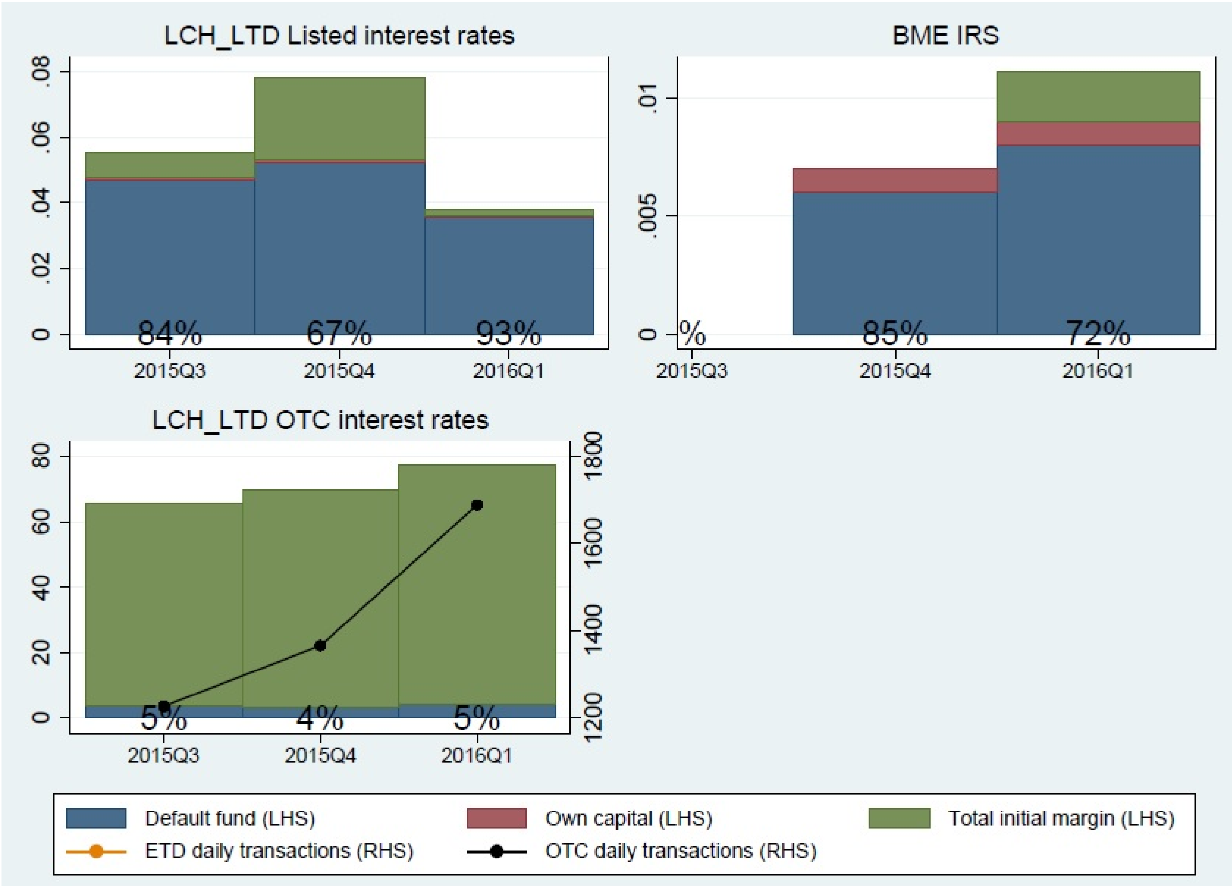
Note: Transaction volumes are notional (or principal) amounts, right-hand side scale (RHS), billion euro. Initial margin, default fund and own capital are also in billion euro, left-hand side scale. Percentages are share of the default fund in total waterfall. CC&G does not provide split by ET and OTC transactions. BME Clearing, LCH.Clearnet SAand LCH.Clearnet LTD also clear non-equity products in this segment. See Table A.5

Figure A.3: Average daily volumes and waterfall. Energy and commodity segment.



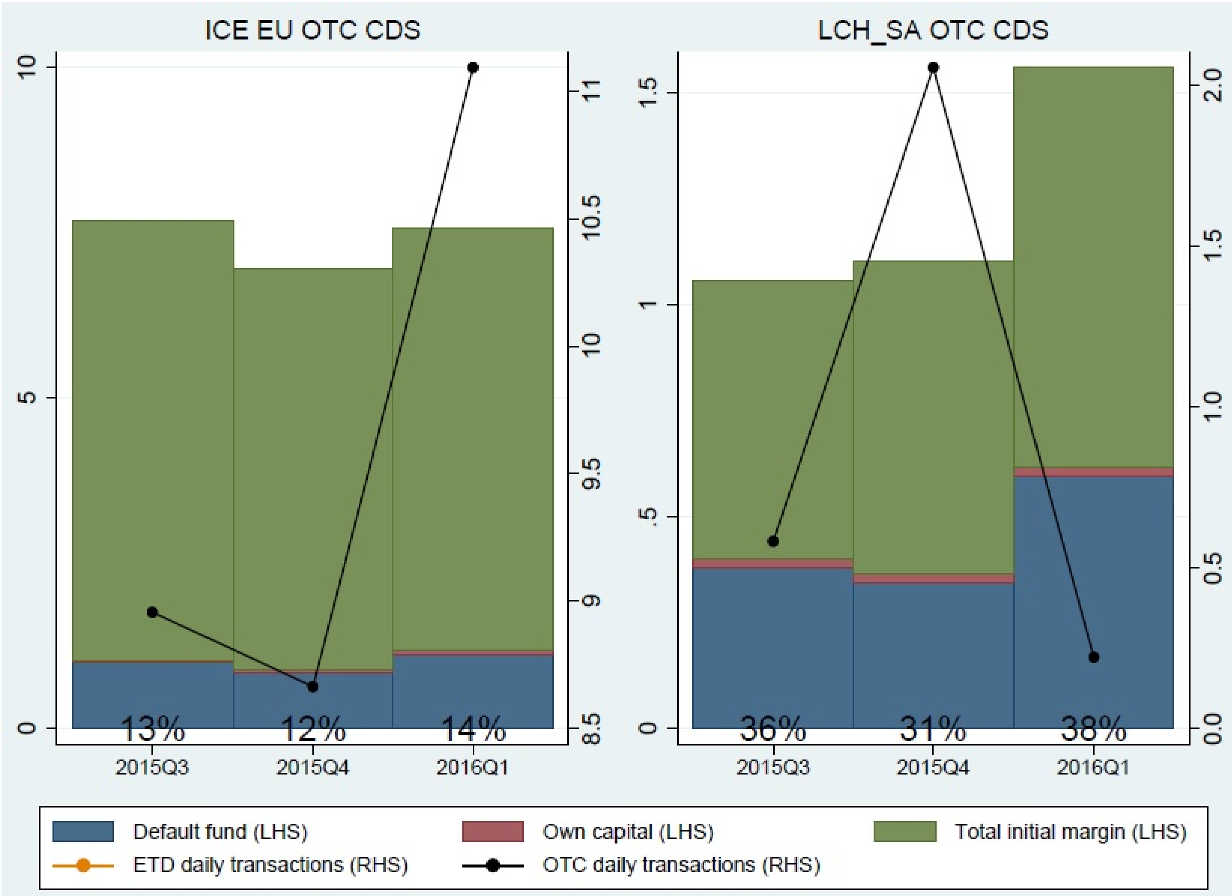
Note: Transaction volumes are notional (or principal) amounts, right-hand side scale (RHS), billion euro. Initial margin, default fund and own capital are also in billion euro, left-hand side scale. Percentages are share of the default fund in total waterfall. CC&G does not provide split by ET and OTC transactions.

Figure A.4: Average daily volumes and waterfall. Interest rate derivatives segment.



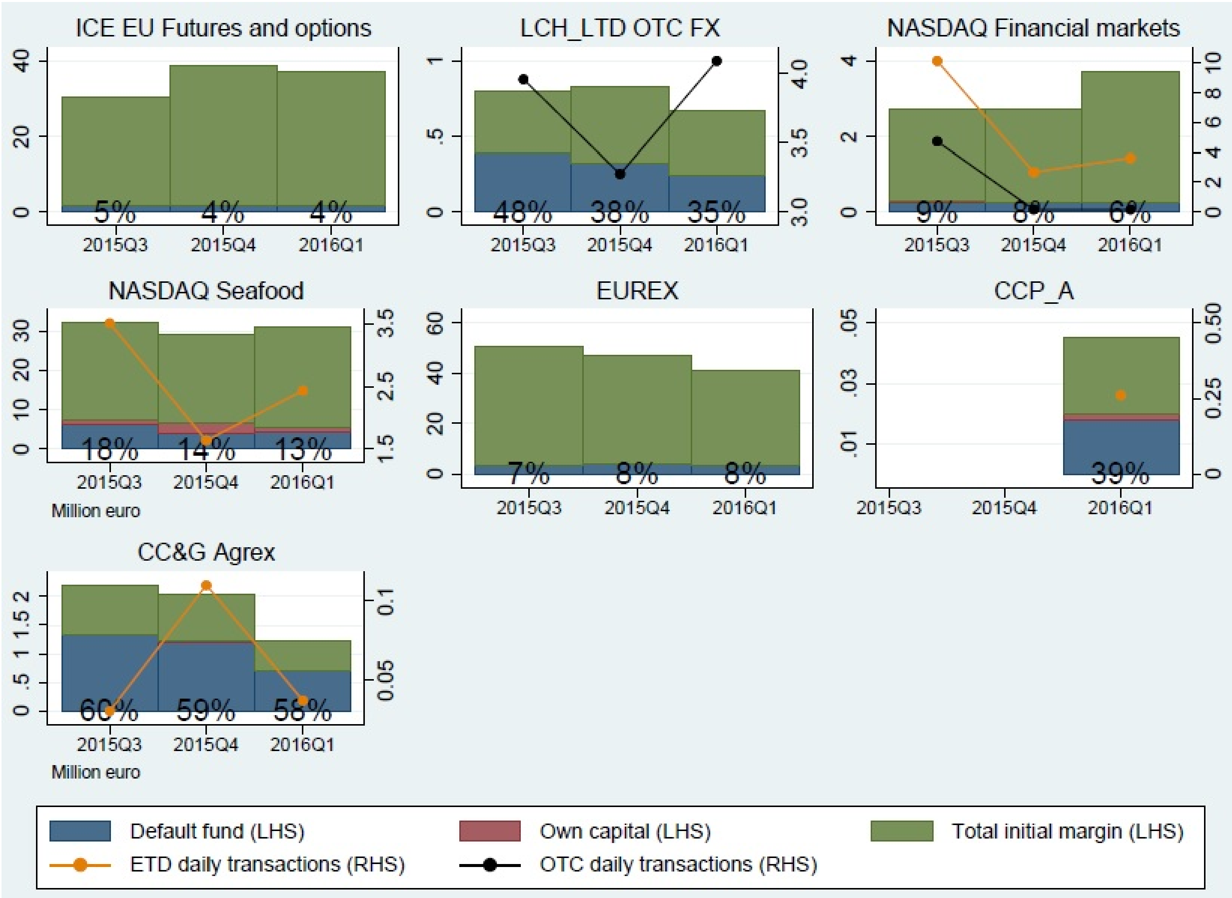
Note: Transaction volumes are notional (or principal) amounts, right-hand side scale (RHS), billion euro. Initial margin, default fund and own capital are also in billion euro, left-hand side scale. Percentages are share of the default fund in total waterfall.

Figure A.5: Average daily volumes and waterfall. OTC CDS segment.



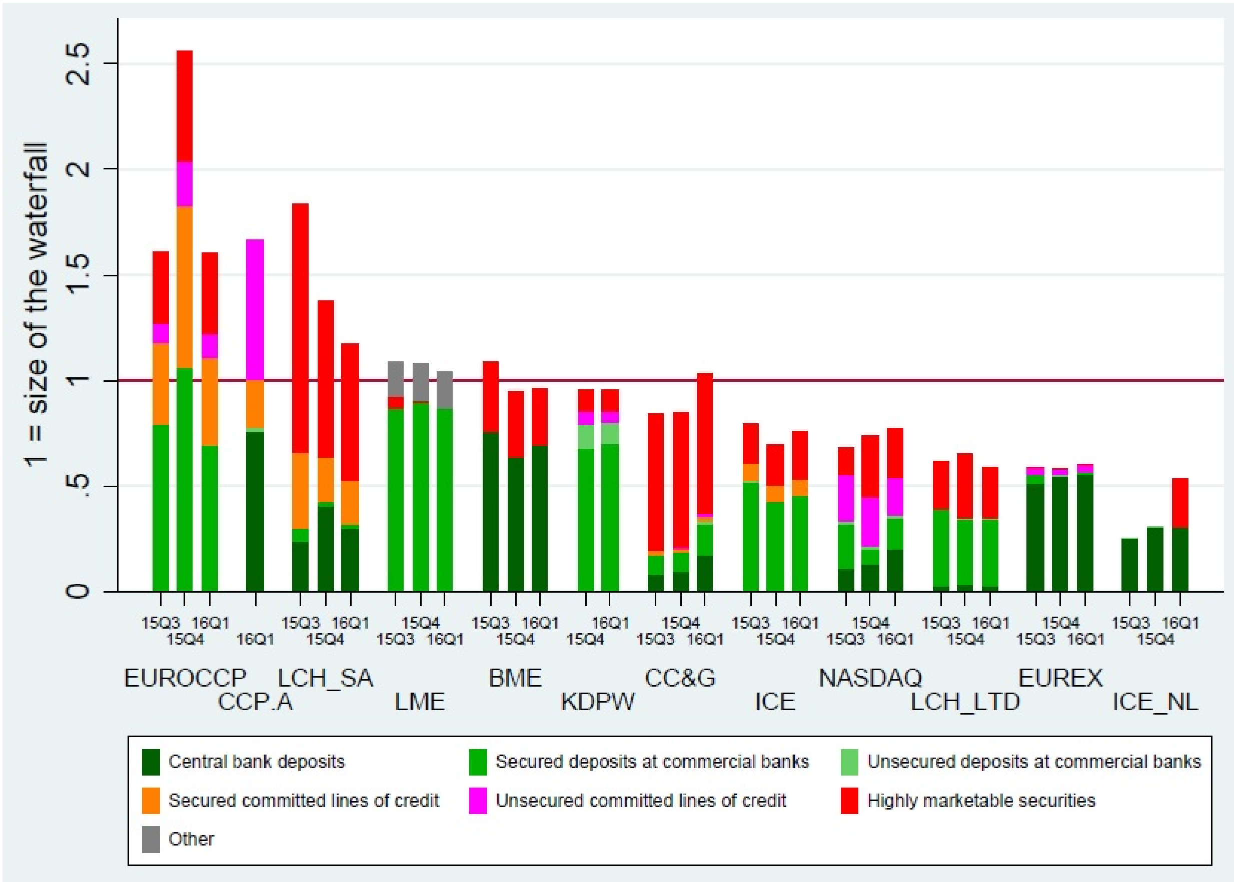
Note: Transaction volumes are notional (or principal) amounts, right-hand side scale (RHS), billion euro. Initial margin, default fund and own capital are also in billion euro, left-hand side scale. Percentages are share of the default fund in total waterfall.

Figure A.6: Average daily volumes and waterfall. Mixed segments.



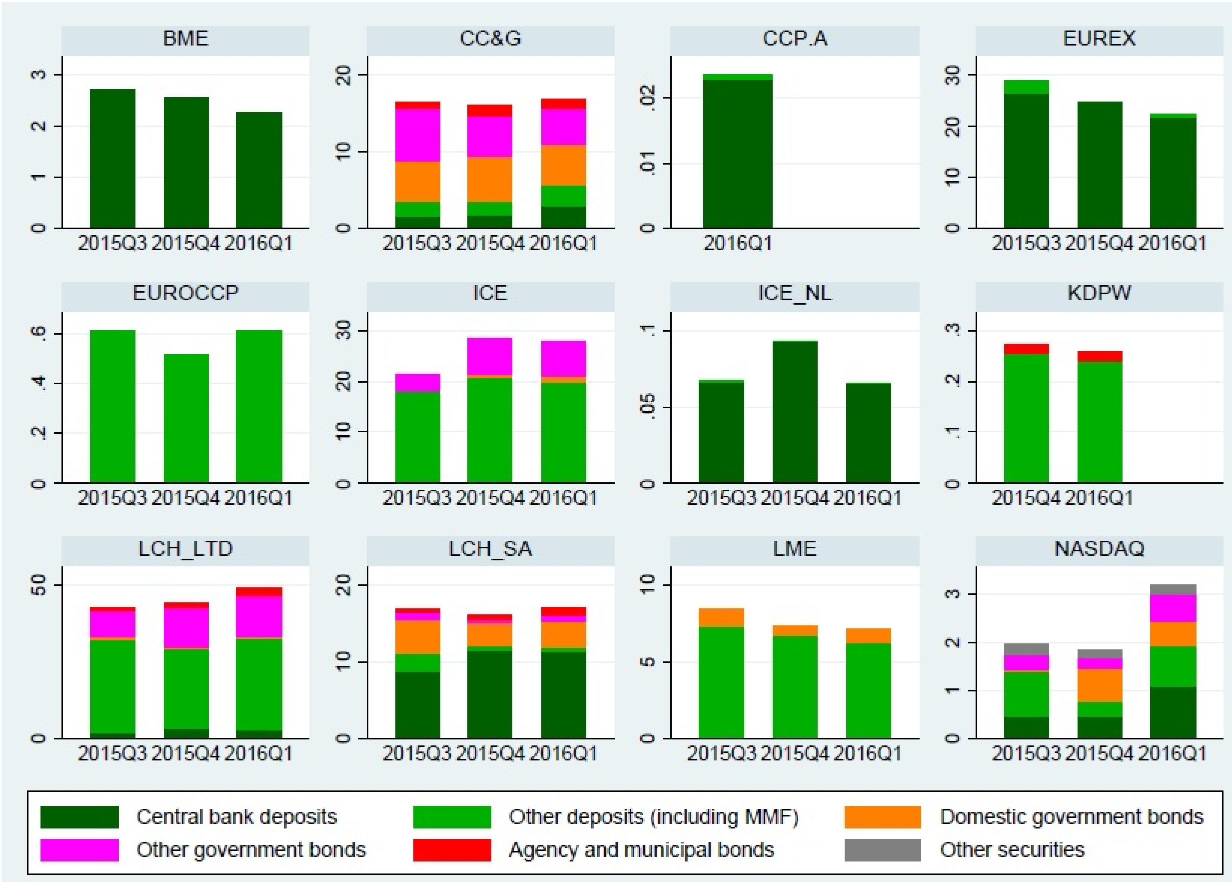
Note: Transaction volumes are notional (or principal) amounts, right-hand side scale (RHS), billion euro. Initial margin, default fund and own capital are also in billion euro, left-hand side scale. Percentages are share of the default fund in total waterfall. For a description of the products cleared, see Table A.9

Figure A.7: Ratio of QLR to total waterfall at CCP level



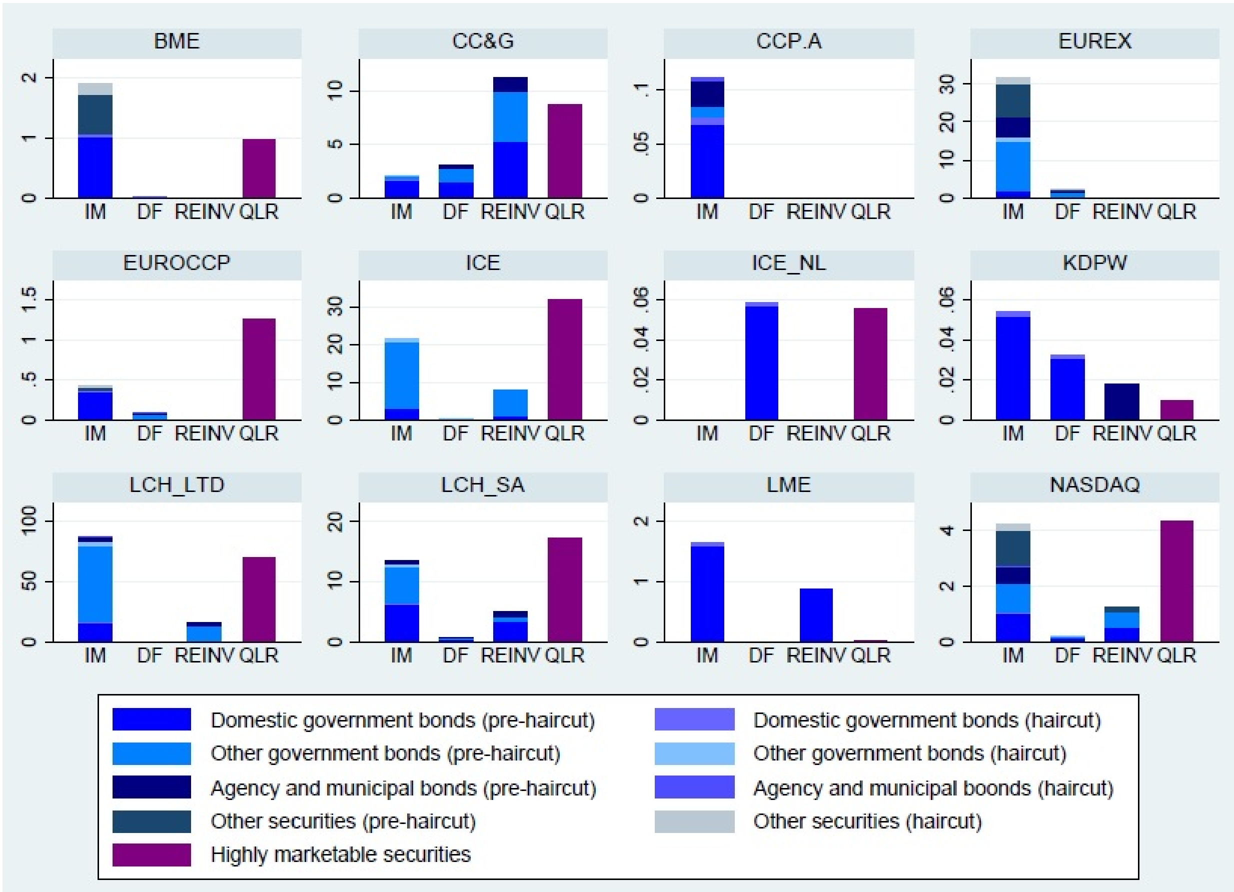
Note: ICE is ICE Clear EU. ICE_NL is ICE Clear NL. LCH_LTD is LCH.Clearnet LTD. LCH_SA is LCH.Clearnet SA. Two CCPs deposits cash at foreign central banks: EuroCCP (less than 0.8% of QLR) and LCH.Clearnet LTD (less than 0.001% of QLR).

Figure A.8: Reinvestment of participant cash



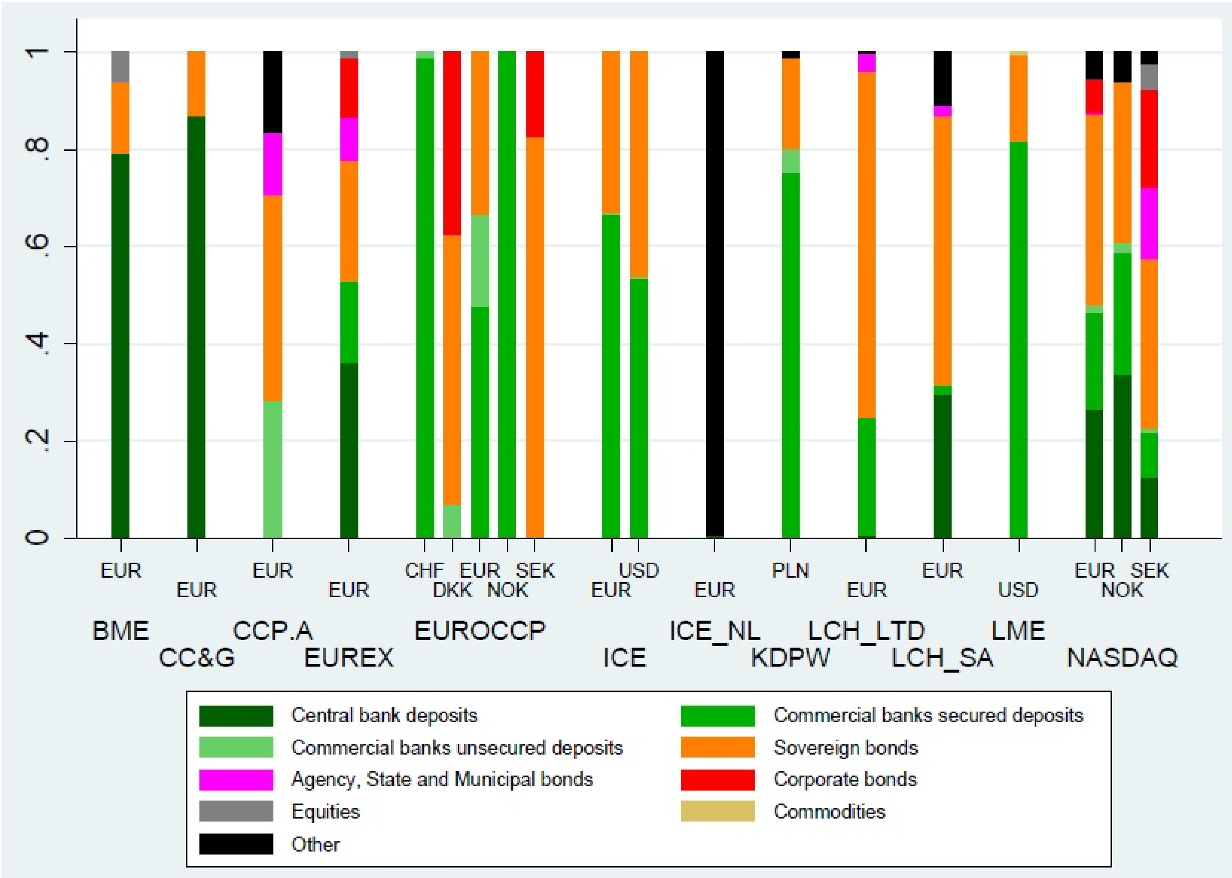
Note: Values in billion euro.

Figure A.9: Focus on securities held



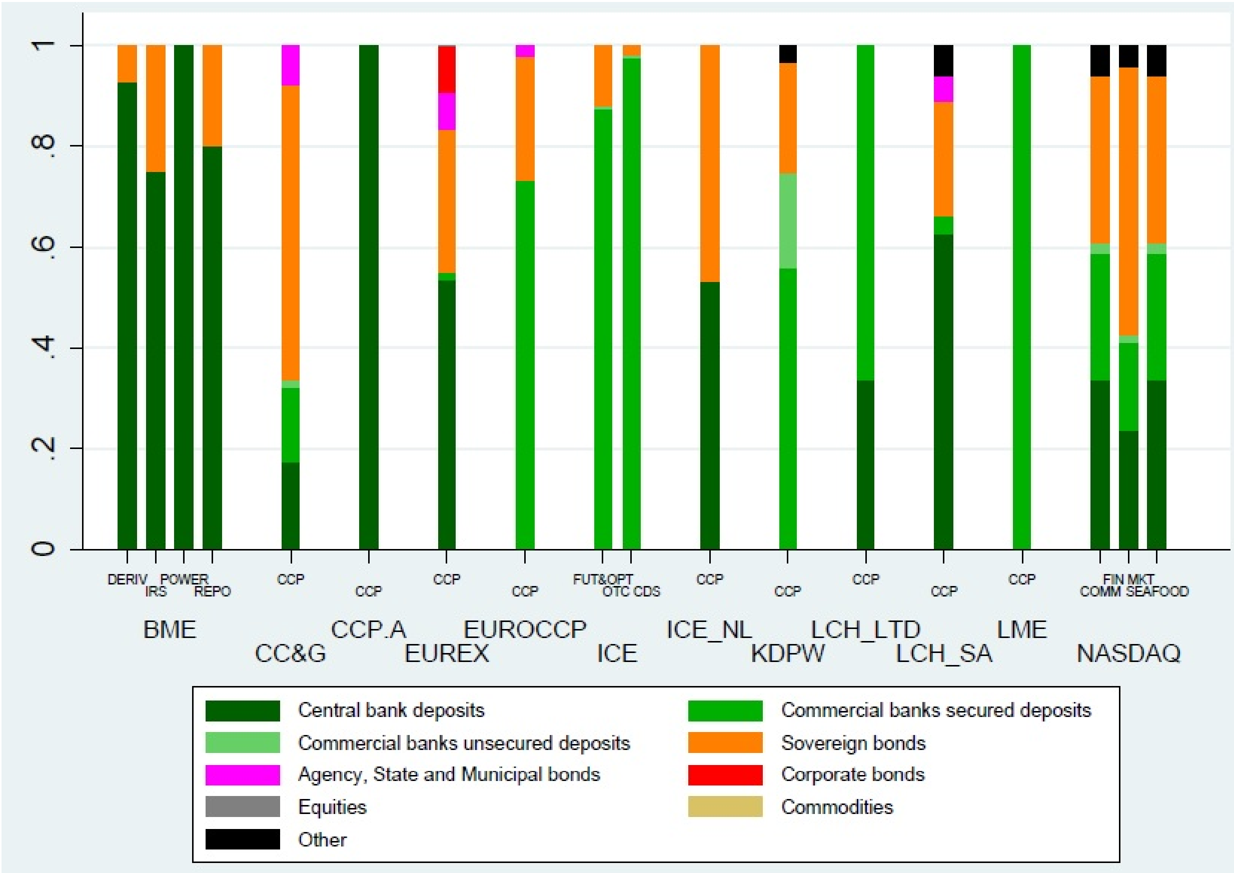
Note: Values in billion euro.

Figure A.10: Composition of initial margin



Note: ICE is ICE Clear EU. ICE_NL is ICE Clear NL. LCH_LTD is LCH.Clearnet LTD. LCH_SA is LCH.Clearnet SA.

Figure A.11: Composition of default funds



Note: ICE is ICE Clear EU. ICE_NL is ICE Clear NL. LCH_LTD is LCH.Clearnet LTD. LCH_SA is LCH.Clearnet SA.

Table A.1: Overview of CCPs in the sample

Group	CCP	Abbreviation	CCP domicile
BME Group	BME Clearing	BME Clearing	Spain
London Stock Exchange Group	Cassa di Compensazione e Garanzia SpA	CC&G	Italy
	CCP Austria Abwicklungsstelle für Börsengeschäfte GmbH	CCP.A	Austria
Deutsche Börse Group	Eurex Clearing AG	Eurex Clearing	Germany
	European Central Counterparty NV	EuroCCP	Netherlands
Intercontinental Exchange INC	ICE Clear Europe LTD ICE Clear Netherlands BV	ICE Clear Europe ICE Clear NL	Netherlands Netherlands
	KDPW CCP	KDPW	Poland
LCH.Clearnet Group LTD	LCH.Clearnet LTD LCH.Clearnet SA	LCH.Clearnet LTD LCH.Clearnet SA	United Kingdom France
London Metal Metal Exchange	LME Clear LTD	LME	United Kingdom
Nasdaq INC	Nasdaq OMX Clearing AB	Nasdaq OMX	Sweden

Note: Data refer to July 2016.

Table A.2: Total number of clearing members and proportions of domestic and foreign participants

CCP	Number of members	Domestic CMs (in percent)	Foreign CMs (in percent)	Average number of clearing memberships
BME Clearing	71	76.06	23.94	3
CC&G	84	75.00	25.00	3
CCP.A	51	50.98	49.02	3
Eurex Clearing	192	32.81	67.19	3
EuroCCP	46	4.35	95.65	4
ICE Clear Europe	77	37.66	62.34	4
ICE Clear NL	3	66.67	33.33	7
KDPW	43	97.67	2.33	1
LCH.Clearnet LTD	153	30.65	69.93	3
LCH.Clearnet SA	102	18.63	81.37	4
LME	44	75	25	4
Nasdaq OMX	247	27.13	72.87	2

Note: Data refer to July 2016.

Table A.3: QLR, Default Resources, and concentration of IM

CCP	QLR (€m)	DR (€m)	QLR/DR	IM5/IM
BME Clearing	3,550	3,700	0.96	0.56
CC&G	13,600	13,100	1.03	0.61
CCP.A	75.3	45.2	1.67	0.55
Eurex Clearing	24,700	41,200	0.60	0.39
EuroCCP	1,520	948	1.60	0.73
ICE Clear Europe	33,800	44,500	0.76	0.46
KDPW	378	394	0.96	0.56
LCH.Clearnet LTD	53,600	90,800	0.59	0.6
LCH.Clearnet SA	31,000	26,400	1.17	0.7
LME	7,580	7,300	1.04	0.39
Nasdaq OMX	4,100	5,290	0.77	0.55

Note: Data from Public Quantitative Disclosures at the first quarter of 2016. QLR is Qualified liquid resources; DR is default resources; IM5/IM is the portion of initial margin posted by the largest 5 clearing members. The latter is a simple average of concentrations at the default fund level. Concentrations are taken at the peak over the quarter.

Table A.4: Products per fixed income default funds

CCP	Segregated default fund	Products covered	Contract type	Underlying
LCH.Clearnet SA	€GC Plus	Fixed income	Triparty Repo	ECB Collateral baskets
LCH.Clearnet SA	Fixed income	Fixed income	Cash trades and repo	Government bonds
CC&G	Bond	ETD Bonds and repo	Bonds and repo	Government bonds corporate bonds
LCH.Clearnet LTD	Fixed Income	Fixed income products	Cash bond and repo trades	Government bonds, German Jumbo bonds, Agency, supranational, regional, government guaranteed bonds, liquid bonds baskets
BME Clearing	Fixed Income Securities	Repo	ETD and OTC	Government bonds

Note: Data refer to September 2016.

Table A.5: Products covered by equity default funds

CCP	Segregated default fund	Products covered	Contract type	Underlying
BME Clearing	Financial derivatives	Listed derivatives	Futures Options	Stock index, 10-yr government bonds, single stock dividend, single stock index American and European style stock, index
LCH.Clearnet SA	Cash and derivatives	Equity cash and derivatives (also bonds and commodities)	Government and corporate bonds Single company equities Cash equities Equities ETFs ETCs REITs Securities Stocks Warrants Certifcates Funds UCITS trackers and structured funds ET commodity derivatives	NA
CC&G	Equity	Equity products and Equity derivatives	Shares, warrants, convertible bonds, closed-end funds, ET funds, exchange traded commodities Futures Options	 Index, single stock Index, single stock
LCH.Clearnet LTD	Equities	Equity products	Single company equities Cash equities ETFs ETCs REITs ccCFDs	equity, index, securities
EuroCCP	EuroCCP NV	ETD and OTC cash equity	NA	NA
ICE Clear NL	Futures and options	European equity derivatives	Futures Options	Index American-style stock, European-style index

Note: Data refer to September 2016.

Table A.6: Products covered by energy and commodity default funds

CCP	Segregated default fund	Products covered	Contract type	Underlying
BME Clearing	Power derivatives	OTC electricity derivatives	Futures Swaps	Electricity Electricity
LCH.Clearnet LTD	Commodities	Derivatives	Block Futures Forward Freight Agreements Forward Freight Agreement options Iron Ore contract Iron Ore option Steel contracts	Fertilizer Dry time charter, dry voyage, dry trip Dry timecharter basket routes TSI index European-style, TSI Iron Ore contract Hot Rolled Coil, Northern Europe Hot Rolled Coil, Southern Europe Turkish Import Scrap
Nasdaq OMX	Commodities	Derivatives	Futures Options Electricity Price Area Differentials Electricity Certificate futures EU Allowance futures EU Allowance options	Power, gas, renewables, freight, fuel oil, ferrous products. Power, gas, freight, ferrous products Power, Electricity Carbon Carbon
CC&G	IDEX	Energy derivatives	Futures	Energy
LME	CCP level	Commodities	Futures Options Traded average price options Monthly average futures	Metal, index, steel Metal Future Metal

Note: Data refer to September 2016.

Table A.7: Products covered by interest rate default funds

CCP	Segregated default fund	Products covered	Contract type	Underlying
BME Clearing	IRS	Interest rate swaps	Swaps	EURIBOR
			OIS	EONIA
			FRA	EURIBOR
LCH.Clearnet LTD	Listed Interest Rates	Listed interest rate derivatives	Futures	EURIBOR, short Sterling, long Gilt, German government bonds
LCH.Clearnet LTD	OTC Interest Rates	OTC interest rate products	IRS	BBR-BBSW, BBR-FRA, BA-CDOR, LIBOR, PRIBOR, CIBOR, EURIBOR, BUBOR HIBOR, NIBOR, WIBOR, STIBOR SOR, JIBAR
			Forward rate agreement	LIBOR, PRIBOR, CIBOR EURIBOR, BUBOR, NIBOR WIBORS, TIBOR
			OIS	AONIA, CORRA, TOIS EONIA, TONA, FEDFUNDS
			Variable Notional Swaps	BBR-BBSW, BA-CDOR, EURIBOR, LIBOR, LIBOR-BBA
			Basis overnight	LIBOR-SONIA, LIBOR-USD, LIBOR-FedFunds, LIBOR-H15, LIBOR-BBA
			Inflation ZCIIS	HICPxT, CPIxT, RPI, CPI

Note: Data refer to September 2016.

Table A.8: Products covered by OTC CDS default fund

CCP	Segregated default fund	Products covered	Contract type	Underlying
ICE Clear Europe	CDS	European CDS	Swaps	Index, corporate single names, Sovereign single names
LCH.Clearnet SA	OTC CDS	Credit default swaps	Swaps	Index, single names

Note: Data refer to September 2016.

Table A.9: Products per mixed default funds

CCP	Segregated default fund	Products covered	Contract type	Underlying
ICE Clear Europe	Futures and options	Energy, agricultural, interest rates, equity derivatives	Futures Options Index	Oil, natural gas, power, coal, Emissions, cocoa, coffee, sugar Wheat, index, dividend index Stock index, government bonds Oil, natural gas, emissions, cocoa, coffee Oil, natural gas, emissions, cocoa, Coffee, sugar, wheat, index, stock Government bonds, bond future
LCH.Clearnet LTD	OTC FX	OTC non-deliverable FX transactions	Forwards	Currency pairs
Nasdaq OMX	Financial Markets	ET and OTC equity derivatives OTC rates Fixed income derivatives Repo products	Futures Options Forwards IRS OIS FRA Futures Options Repos	Single stock, index Single stock, index, fixed income Single stock STIBOR, CIBOR, EURIBOR, NIBOR STIBOR STIBOR, CIBOR, EURIBOR, NIBOR Government and mortgage bonds, rates Government and mortgage bonds, rates Bonds
Nasdaq OMX	Seafood	Salmon derivatives	Futures	Nasdaq Salmon Index
Eurex Clearing	Integrated default fund	All products cleared	All contracts cleared	NA
CCP.A	Integrated default fund	Equity market Bond market Structured products Other securities	Stocks Government bonds, federal treasury certificates, Treasury notes, interest rate and government strips, Corporate and banking bonds, convertible bonds. Certificates, exchange traded funds, warrants Profit-sharing rights, UCITS shares, stocks	NA
CC&G	AGREX	Agricultural Derivatives	Futures	Durum Wheat

Note: Data refer to September 2016.

AppendixB. Overview of PQD variables used per Figure

This section is to provide an overview of the PQD variables used in the paper and the modifications that were necessary to make the data, partly provided in differing currencies or measuring units, comparable and to enable data aggregation.

AppendixB.1. PQD variables used

In Tables B.10 and B.11, an overview of the different variables extracted from the PQD data files provided by each CCP is provided. The figures were converted to euro using either end-of-period (quarter end) or period-average exchange rates (quarterly) depending on the PQD 'snapshot type'.

AppendixB.2. PQD variables used

In Tables B.10 and B.11, an overview of the different variables extracted from the PQD data files provided by each CCP is provided. The figures were converted to euro using either end-of-period (quarter end) or period-average exchange rates (quarterly) depending on the PQD 'snapshot type'.

Table B.10: Overview of PQD variables used

Figure reference	Measure of	PQD reference variable(s) used	Variable description	Data unit
A.1 to A.5	Default waterfall size and stucture	4.1.1[B]	Prefunded CCP capital[1] (SIG)	EUR,GBP,HUF,JPY, NOK,PLN,SEK,USD
		4.1.2[B]	Prefunded CCP capital[1] alongside default fund	EUR,GBP,HUF,JPY NOK,PLN,SEK,USD
		4.1.3[B]	Prefunded CCP capital[1] after default fund	EUR,GBP,HUF,JPY, NOK,PLN,SEK,USD
		4.1.4[B]	Required prefunded participants' default fund contributions[1]	EUR,GBP,HUF,JPY, NOK,PLN,SEK,USD
		6.1.1[B]	Total initial margin required[1] split by house, client gross, client net and total (if not segregated)	CHF,DKK,EUR,GBP, NOK,PLN,SEK,USD
A.7	Ratio of qualifying liquid resources to total waterfall resources[A]	7.1.2[B]	Cash[2] deposited at a central bank of issue of the currency concerned	CHF,DKK,EUR,GBP, NOK,PLN,SEK,USD
		7.1.3[B]	Cash[2] deposited at other central banks	CHF,DKK,EUR,GBP, NOK,PLN,SEK,USD
		7.1.4[B]	Cash[2] Secured cash deposited at commercial banks (including reverse repo)	CHF,DKK,EUR,GBP, NOK,PLN,SEK,USD
		7.1.5[B]	Unsecured cash[2] deposited at commercial banks	CHF,DKK,EUR,GBP, NOK,PLN,SEK,USD
		7.1.6[B]	Secured[2] committed lines of credit including foreign exchange swaps and committed repos	CHF,DKK,EUR,GBP, NOK,PLN,SEK,USD
		7.1.7[B]	Unsecured committed lines of credit[2]	CHF,DKK,EUR,GBP, NOK,PLN,SEK,USD
		7.1.8[B]	Highly[2] marketable collateral held in custody and investments that are readily available and convertible into cash with prearranged and highly reliable funding arrangements even in extreme but plausible market conditions	CHF,DKK,EUR,GBP, NOK,PLN,SEK,USD
		7.1.9[B]	Other	CHF,DKK,EUR,GBP, NOK,PLN,SEK,USD
A.8	Rein-vestment of cash received from members	16.1.1[B]	Total cash[3] (but not securities) received from participants as IM	DKK,EUR,GBP,NOK, PLN,SEK,USD
		16.1.2[B]	Total cash[3] (but not securities) received from participants as default fund contribution	EUR,GBP,NOK, PLN,SEK,USD
		16.2.1[B]	Percentage of total participant cash held as cash deposits[4]	Percentage
		16.2.2[B]	Percentage of total participant cash held as cash deposits[4] at central banks of issue of the currency deposited	Percentage
		16.2.3[B]	Percentage of total participant cash held as cash deposits[4] at other central banks	Percentage
		16.2.4[B]	Percentage of total participant cash held as cash deposits[4] at commercial banks[5]	Percentage
		16.2.5[B]	Percentage of total participant cash held as cash deposits[4] at commercial banks[6]	Percentage

Remark 1:[1]split by clearing service if default funds are segregated by clearing service; [2]Size and composition of qualifying liquid resources for each clearing service; [3]regardless of the form in which it is held, deposited or invested, split by whether it was received as initial margin or default fund contribution; [4]including through reverse repo;[5]Secured, including through reverse repo;[6]Unsecured.

Remark 2:[A]The PQD variables used for Figure **??** to Figure A.5 are also used for Figure A.7. [B] The PQD variable is reported at quarter end. [C] The PQD variable is reported quarterly.

Table B.11: Overview of PQD variables used (continued)

Figure reference	Measure of	PQD reference of variable(s) used	Variable description	Data unit
		16.2.6[B]	Percentage of total participant cash held as cash deposits[1] in money market funds	Percentage
		16.2.7[B]	Percentage of total participant cash held as cash deposits[1] in other forms	Percentage
		16.2.10[B]	Percentage of total participant cash invested in securities; Domestic sovereign government bonds	Percentage
A.8		16.2.11[B]	Percentage of total participant cash invested in securities; Other sovereign government bonds	Percentage
		16.2.12[B]	Percentage of total participant cash invested in securities; Agency bonds	Percentage
		16.2.13[B]	Percentage of total participant cash invested in securities; State or municipal bonds	Percentage
		16.2.14[B]	Percentage of total participant cash invested in securities; Other instruments	Percentage
		4.3.5[B]	Non-Cash Sovereign Government Bonds-Domestic[2,3]	EUR,NOK,PLN,SEK,USD
	Focus	4.3.6[B]	Non-Cash Sovereign Government Bonds-Other[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.7[B]	Non-Cash Agency Bonds[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.8[B]	Non-Cash State/municipal bonds[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.9[B]	Non-Cash Corporate bonds[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.10[B]	Non-Cash Equities[2,3]	EUR,NOK,PLN,SEK,USD
A.9	on	6.2.5[B]	Non-Cash Sovereign Government Bonds - Domestic[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.6[B]	Non-Cash Sovereign Government Bonds - Other[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.7[B]	Non-Cash Agency Bonds[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.8[B]	Non-Cash State/municipal bonds[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
	bonds[A]	6.2.9[B]	Non-Cash Corporate bonds[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.10[B]	Non-Cash Equities[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.1[B]	Cash deposited at a central bank of issue of the currency concerned[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
	Com-	6.2.2[B]	Cash deposited at other central banks[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.3[B]	Secured cash deposited at commercial banks[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.4[B]	Unsecured cash deposited at commercial banks[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
	position	6.2.5[B]	Non-Cash Sovereign Government Bonds-Domestic[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.6[B]	Non-Cash Sovereign Government Bonds-Other[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.7[B]	Non-Cash Agency Bonds[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
A.10		6.2.8[B]	Non-Cash State/municipal bonds[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
	of	6.2.9[B]	Non-Cash Corporate bonds[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.10[B]	Non-Cash Equities[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.11[B]	Non-Cash Commodities-Gold[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.12[B]	Non-Cash Commodities-Other[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.13[B]	Non-Cash-Mutual Funds OR UCITs[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
	IM	6.2.14[B]	Non-Cash-Other[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		6.2.15[B]	Total initial margin held[2,4]	CHF,DKK,EUR,NOK,PLN,SEK,USD
		4.3.1[B]	Cash deposited at a central bank of issue of the currency concerned of issue of the currency concerned[2,3]	EUR,NOK,PLN,SEK,USD
	Com-	4.3.2[B]	Cash deposited at other central banks[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.3[B]	Secured cash deposited at commercial banks[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.4[B]	Unsecured cash deposited at commercial banks[2,3]	EUR,NOK,PLN,SEK,USD
	position	4.3.5[B]	Non-Cash Sovereign Government Bonds-Domestic[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.6[B]	Non-Cash Sovereign Government Bonds-Other[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.7[B]	Non-Cash Agency Bonds[2,3]	EUR,NOK,PLN,SEK,USD
A.11		4.3.8[B]	Non-Cash State and municipal bonds[2,3]	EUR,NOK,PLN,SEK,USD
	of	4.3.9[B]	Non-Cash Corporate bonds[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.10[B]	Non-Cash Equities[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.11[B]	Non-Cash Commodities-Gold[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.12[B]	Non-Cash Commodities-Other[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.13[B]	Non-Cash Commodities-Mutual Funds and UCITs[2,3]	EUR,NOK,PLN,SEK,USD
	DF	4.3.14[B]	Non-Cash Commodities-Other[2,3]	EUR,NOK,PLN,SEK,USD
		4.3.15[B]	In total[2,3]	EUR,NOK,PLN,SEK,USD

Remark 3:[1] including through reverse repo; [2] pre- and post-haircut; [3]held for each clearing service, in total and split by; [4] for each clearing service, total initial margin held, split by house and client.

Remark 2:[A] The PQD variables 16.1.1-16.1.2, 16.2.10-16.2,14, and 7.1.8 are also used for the calculation of this measure. [B] The PQD variable is reported at quarter end.

AppendixB.3. Explanatory notes on Figures

The PQD data used for the figures mentioned in Table B.12 cannot be be used in a straight-foward manner. This section provides a short overview of the necessary modifications to the original data provided by the CCPs per Figure.

Figures on size CC&G, LCH.Clearnet LTD, and LCH.Clearnet SA report transactions assigning them to clearing services, as opposed to default funds. In the figures, we re-named the default funds to highlight which kind of transaction is cleared. For the remainder of the respective paragraph, we use the naming conventions used by the CCPs in their PQD data files to enable the reader to clearly understand the separation between *clearing service* and *default fund*. The following assignments of clearing service(s) to default fund were made:

Table B.12: Assignments of clearing service to default fund per CCP

CCP	Clearing Service as specified in PQD file	Assigned default fund
CC&G	Wholesale	Bonds
	Retails	
	Derivatives	Equity
	Equities	
LCH.Clearnet LTD	EnClear	Commodities
	LSEDM	Equities
	RepoClear	Fixed Income
	NLX	Listed Interest Rates
	ForexClear	OTC FX
	SwapClear	OTC Interest Rates
LCH.Clearnet SA	EquityClear	Cash and Derivatives
	Listed Derivatives	
	Triparty Repo	GC€ Plus
	Bonds and Repos	Fixed Income
	CDSClear	OTC CDS

Additionally, the double reporting of repos (as repo and reverse) reported by LCH.Clearnet LTD and LCH.Clearnet SA was rectified. Finally, differences in reporting units across quarters were aligned: for example, LCH.Clearnet LTD reported in millions of euro for the clearing service RepoClear in the first quarter of 2016.

Figures containing PQD reference variables relating to CCP capital (4.1.2 and 4.1.3) The PQD reference variables 4.1.2 and 4.1.3 refer to the own capital of the CCP to be used alongside and after non-defaulting clearing members contributions to the default fund (PQD reference variable 4.1.4), respectively. For regulatory reasons, they are not allocated to each default fund, thus the reporting in the PQD data is at the CCP level. To be used in the measures proposed in this paper, these CCP capital resources are allocated to each default fund in proportion to the amounts of the CCP's SIG for the respective default fund.

Figure A.7 The QLR concept (denominator), covering PQD reference variables 7.1, refers to how financial resources are held by the CCP. The pre-funded waterfall amounts (that are part of the denominator) are required amounts (default fund (4.1.4) and initial margin (6.1.1)). This approach was chosen as to compare the liquid resources to the resources available to the CCP, excluding any over-collateralisation.

Figure A.9 For the IM, we use total IM held in securities, covering PQD reference variables 6.2.. 'Domestic governemnt bonds' and 'Other government bonds' refer to PQD reference variables 6.2.5 and 6.2.6, respectively. The proportion named 'Agency and Municipal bonds' is the sum of PQD reference variables 6.2.7 and 6.2.8. 'Other securities' covers corporate bonds (PQD reference variable 6.2.9) and equities (PQD reference variable 6.2.10). Similarly, for DF we use concept 4.3 or 'Value of pre-funded default resources (excluding initial and retained variation margin)', split into the same buckets as PQD reference variables 6.2.5 to 6.2.10. All figures are converted to euro at end-of period exchange rates before being summed up in order to get total IM and DF resources held in securities in any currency.

Total cash received as IM or DF reinvested in securities is obtained using concept 16.1: 'Total cash (but not securities) received from participants, regardless of the form in which it is held, deposited or invested, received as' initial margin (PQD reference variable 16.1.1) and default fund (PQD reference variable 16.1.2) and PQD reference variables 16.2.10 to 16.2.14, on 'Percentage of total participants cash invested in securities', split by domestic and foreign sovereign, agency, municipal and other securities. The QLR PQD reference variable is 7.1.8, 'Highly marketable collateral held in custody and investments that are readily available and convertible into cash with prearranged and highly reliable funding arrangements even in extreme but plausible market conditions'.

Figure A.9 aims at showing how CCPs hold the securities within default resources and in turn the extent to which the securities held have been invested into by the CCP using cash posted by clearing members or they have been posted by members directly. Concepts 4.3 and 6.2 refer to how the CCP is holding IM and DF, rather than how members have posted resources. Therefore, according to the PQD standards, the sum of PQD reference variables 4.3.5 to 4.3.10 and 6.2.5 to 6.2.10 (sum of the first and second sets of stacked bars) should be at most equal to the third set of stacked bars. Equality holds when the CCP receives all IM and DF contributions in cash, and the securities held as IM or DF are only those into which the CCP has reinvested participant cash. Conversely, when the reinvestment bar is zero, all securities in IM and DF are those posted by members. The difference between the sum of the first two bars and the third bar in the chart is the collateral posted in securities by participants.

However, in Figure A.9, the reinvestment bar is greater than the sum of DF and IM bars for CC&G.

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