



European Securities and
Markets Authority

Report

3rd EU-wide CCP Stress Test



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Acronyms used

EMIR	European Market Infrastructures Regulation – Regulation (EU) 648/2012 of the European Parliament and Council on OTC derivatives, central counterparties and trade repositories
ESMA	European Securities and Markets Authority
ESRB	European Systemic Risk Board
ETD	Exchange Traded Derivatives
FX	Foreign Exchange
LEI	Legal Entity Identifier
NCA	National Competent Authority
OTC	Over the counter
RTS	Regulatory Technical Standards
bps	Basis points
EU	European Union
P&L	Profit and Loss
pp	Percentage points
SITG/SIG	Dedicated CCP Resources (“Skin in the game”)
HHI	Herfindahl-Hirschman index used for the assessment of concentration
DvP	Delivery versus Payment

1 Executive Summary

Reasons for publication

The European Securities and Markets Authority (ESMA), in accordance with EMIR, shall initiate and coordinate Union-wide assessments of the resilience of Central Counterparties (CCPs) to adverse market developments. This report presents the results of the third EU-wide CCP stress test exercise.

Contents

In line with the methodology published in April 2019, the exercise covers both credit and liquidity risk, with targeted improvements in the methodology compared to the two previous exercises. In addition, the exercise includes for the first time an assessment of the impact of liquidation costs for concentrated positions (concentration risk).

Given the scope and type of this exercise, a number of limitations remain and have been highlighted in the report. Considering the nature of the exercise and its sensitivity to some of its inputs, the results could be affected by errors in the data provided or assumptions used by CCPs to compute these data. This is particularly true for the concentration component of the exercise, the methodology and assumptions of which have been applied for the first time. The concentration stress test results are therefore presented on an anonymous basis.

As with previous exercises, the objective of the EU-wide stress test exercise is to assess the resilience of EU CCPS to adverse market developments. This exercise is not aimed at assessing the compliance of the CCPs with regulatory requirements, nor at identifying any potential deficiency of the stress testing methodology of individual CCPs. Despite the fact that it is not aimed to do so, it may expose individual shortcomings in the resilience of CCPs, in which case ESMA will issue the necessary recommendations.

The stress test results are presented in section 0 of the report.

Analysis of CCP financial resources

Section 4.1 provides an analysis of the financial resources held by the 16 in-scope CCPs, as of 8 March 2019. This data gives an overview of the size of the industry and identifies common practices and divergences with potential risk implications. Overall, the prefunded resources collected by CCPs have increased compared to the previous stress exercise. The CCPs reported in total approximately 335 billion EUR of required margin, default fund contributions and other committed prefunded resources. The analysis shows that, while there was a general increase of provided resources by all clearing members, at the same time the top participants increased their relative share. No significant evolution was observed compared to the previous exercise regarding the breakdown of resources to different asset types. Concerning cash, we see that a significantly larger share of the cash is now kept at central banks

Interconnectedness and clearing member (CM) Concentration

The interconnectedness between CCPs through common clearing members, custodians and liquidity providers is analysed in section 4.2.1. As observed in the previous exercise, the EU central clearing environment appears to be very interconnected, since most CCPs are connected to several of the top-10 EU clearing member groups. The analysis also shows some level of interconnectedness through custodians, including in particular two CSDs and one non-EU custodian bank. Regarding top common liquidity providers, not many CCPs have reported committed repo lines from commercial entities. Moreover, there is no evidence suggesting single financial groups committed to providing liquidity to many CCPs at the same time.

The level of concentration to individual clearing members has also been assessed, using the Herfindahl - Hirschman Index (HHI) methodology and thresholds. The results presented in section 4.2.2 do not show any systemically critical concentration to single clearing members or groups at EU-wide level.

Credit Stress Test

The results of the credit stress test are presented in section 4.3. Two default scenarios have been run, combined with the common market stress scenario. The first scenario is a Cover-2 per CCP, where we assume the default of two clearing member groups separately at each CCP. The second scenario is the EU-wide Cover-2 scenario, where we assume the default of the same two groups for all CCPs EU-wide. The defaulting entities are selected as the groups which maximize the shortfall of prefunded resources, or alternatively the groups which maximize the overall consumption of prefunded resources. Both scenarios have been run on two different dates, 21 December 2018 and 8 March 2019.

Under the Cover-2 per CCP scenario, we assess the resilience of each CCP to the default of its top-2 clearing members groups under common price shocks. For the March date, one CCP (LME) would exhibit a shortfall of prefunded resources. This shortfall would have to be covered with additional non-prefunded resources that the CCP has the right to call from its non-defaulting members, leaving no losses uncovered. For the December date, the cover-2 per CCP scenario does not generate a shortfall of prefunded resources at any CCP. We analysed the sensitivity of the results to changes of the severity of the market shocks. Assuming a 30% decrease in severity, there would be no shortfall of prefunded resources. If instead one would further increase the already extreme shocks by 20%, more CCPs would be impacted showing an increased sensitivity in some cases, without however raising any additional, systemically relevant concerns at individual CCPs. During the time of finalisation of the exercise, the Covid-19 outbreak led to sharp and extreme market movements for instruments across the majority of asset classes. A brief analysis of the stress scenarios in the light of the Covid-19 outbreak market moves is presented in Box 2.

The EU-wide Cover-2 stress test scenario is designed to assess the resilience of CCPs collectively to the market stress scenario. Under this scenario, the same two groups of clearing members are assumed to be in default in all CCPs. For the March date, after selecting the two groups that maximize the shortfall of prefunded resources, the results logically focus on the case already highlighted in the Cover-2 per CCP scenario. The selection of the same two clearing member groups defaulting in all CCPs has a rather limited impact on the other CCPs (the consumption of prefunded resources remains below 20% in all cases). For this reason, we also analysed the EU-wide Cover-2 results after selecting the groups that would maximize the overall impact, without focusing on the ones that would

create the maximum shortfall. This selection still produces a shortfall of prefunded resources for the same CCP, though smaller. Under this selection, thirteen CCPs are impacted by a default, with one to twelve clearing members belonging to at least one of the two defaulting groups. This shows that the default of a single clearing member group can lead to a surprisingly large number of individual members defaulting. For the December 2018 date, no shortfall is observed in any CCP. Overall, this combination of defaulting groups would lead to at least one default for thirteen CCPs, with the number of single defaulting entities ranging from one to nine per CCP, and an aggregate impact of approximately 3.4 billion EUR of losses after margin (vs 2.7 billion EUR for the March date).

A knock-on analysis is presented in section 4.3.2.3. It aims to assess the potential systemic risk implications from non-defaulting clearing members losing resources because of the loss-sharing mechanism of CCPs. Overall, the analysis showed no evidence of systemic implications from second round effects to non-defaulting members. The main reason is that for the EU-wide scenarios we did not find many CCPs being severely hit at the same time, something that could have led to high losses to non-defaulting clearing members.

Finally, the reverse stress analysis discussed in section 0 tries to capture the sensitivity of the credit stress results to small changes of the underlying assumptions. For that purpose, we increased both the severity of the stress test shocks and the number of defaulting clearing member groups. Taking as a starting point the base scenario and two defaulting groups, the analysis shows that incremental changes in market shock severity are more harmful than increases in the number of defaulting groups.

Concentration Stress Test

The results of the concentration stress tests are presented in section 4.5. Based on the sensitivity data provided by CCPs, the market impact (liquidation cost) was computed for all identified concentrated positions on one reference date (8 March 2019).

The EU-wide concentration analysis shows that concentrated positions represent a significant risk for EU CCPs. For most asset classes, concentrated position risk is clustered in one or 2 CCPs. EU-wide, the largest concentration risk can be found in fixed income (around 20bn EUR). Concentration in commodity derivatives and in the equity segment (securities and derivatives) is very significant as well, with around 9.5bn EUR of concentration risk.

Data reported by CCPs shows that concentration risk is explicitly factored in in a majority of CCPs through dedicated margin add-ons. However, 4 CCPs did not report any concentration add-on. For 3 out of those 4 CCPs, the required margins are much larger than the market impact. For one CCP the market impact is significant although this represents less than 6% of the required margin.

EU-wide, those reported concentration add-ons are much lower than market impact risk for commodity derivatives, and to a lesser extent for equity products.

The analysis of individual clearing members coverage shows that concentration risk is not always covered properly, as 4 CCPs have at least a clearing member whose market impact exceeds its total required margin. This highlights the importance for margin models to not only be conservative but also accurate in capturing concentration risk. This is even true for liquid markets, where large positions can build up very quickly.

Finally, the prudential analysis of the impact of concentrated positions on mutualised resources demonstrates that CCPs should properly take into account the liquidation costs when sizing their default fund.

Liquidity Stress Test

The results of the liquidity stress tests are presented in section 4.6. As with the credit component, two default scenarios have been run, a “Cover 2 per CCP” scenario, and an “EU-wide Cover 2” scenario. Both scenarios have been run on a single reference date (8 March 2019). Selected defaulting entities are the ones which maximize the liquidity exposures when all assumptions are applied (no excess margin, 1-day market access delay, 2 days settlement lag, no access to FX market).

Note that the liquidity stress test results should be only interpreted as an additional finding to the credit stress test results and remain specific to the date selected as well as the assumptions retained for this exercise.

Overall, the liquidity results show EU CCPs to be resilient under the implemented scenarios and tested assumptions. Only a few CCPs exhibit a shortfall in at least one currency, which means that they would need to transform some of their resources available in one currency into another currency in order to match their liabilities in a timely manner. However, the amounts are negligible compared to the size of the spot FX market.

Overall Results

This year’s exercise demonstrates that EU CCPs are overall resilient under the implemented common shocks and multiple defaults scenarios. As with the previous exercise, the adverse scenario did not aim to cover all possible market movements but was designed to provide an internally consistent narrative to assess the resilience of EU CCPs to EU-wide market shocks.

The credit stress test highlighted differences in resilience between CCPs under the selected market stress scenario, although no systemic risk has been identified. Similarly, the liquidity stress test showed EU CCPs to be resilient under the considered scenarios and did not reveal any systemic risk. Finally, the new concentration component added a new dimension to the exercise and highlighted the need for EU CCPs to accurately account for liquidation cost within their risk framework.

During the time of finalisation of the exercise, the Covid-19 outbreak led to sharp and extreme market movements for instruments across the majority of asset classes. ESMA, in coordination with the NCAs, closely monitored the impact that the outbreak may have had on EU CCPs. Overall, ESMA notes that EU CCPs remained resilient through the crisis, despite the increased market volatility and operational risk.

Next Steps

In line with the EMIR mandate, where the assessments expose shortcomings in the resilience of one or more CCPs, ESMA will issue the necessary recommendations.

2 Introduction

2.1 Background

1. Central Counterparties (CCPs) can be systemically important and ensuring their resilience is critical to achieve the stability of the financial system. They were setup to reduce systemic risk stemming from bilateral relationships. They are however counterparties to all their clearing members, and thus any shortcomings leading to a failure to mitigate risks could potentially lead to spill-over effects and exacerbate systemic risk.
2. CCPs run daily stress tests based on stringent prudential requirements that focus on their own environment (participants, cleared products, activity). The individual stress tests run by CCPs are necessary but cannot always reveal implications from system-wide events because of their limited scope. As shown in previous EU-wide stress exercises conducted by ESMA, CCPs are interconnected through common participants. Therefore, the EU-wide picture is necessary to identify potential emerging systemic risks.
3. One of the objectives of EMIR (Regulation (EU) No 648/2012 of the European Parliament and of the Council of 4 July 2012 on OTC derivatives, central counterparties and trade repositories) is to promote central clearing and ensure safe and resilient CCPs. Therefore, ESMA shall, in cooperation with the ESRB, initiate and coordinate Union-wide assessments of the resilience of CCPs to adverse market developments. Where the assessment exposes shortcomings in the resilience of one or more CCPs, ESMA shall issue the necessary recommendations.
4. The present report sets out the results of the 3rd EU-wide stress test exercise in Section 0, following a description of the employed methodology in Section 3. The objectives, scope and overview of the different tests performed are presented in the following paragraphs of this section.

2.2 Scope and Objectives

5. The objectives of the EU-wide stress test exercise come directly from the legal mandate given to ESMA under EMIR. The objectives are to:
 - Assess the resilience of CCPs to adverse market developments,
 - Identify any potential shortcomings in the CCPs' resilience, and
 - Issue recommendations as appropriate.
6. The overall design of the stress test framework was also guided by a number of overarching principles. ESMA has assessed the resilience of all CCPs in scope, individually and as a system. This was done on the basis of, as much as possible, common methodologies and criteria. The market shocks and stress assumptions were combined with the simultaneous default of market participants, while the scenario design considered the EMIR prudential requirements. The EU-wide CCP stress testing exercise is not aimed at assessing the compliance of the CCPs with regulatory requirements nor at identifying any potential deficiency of the stress testing methodology of individual CCPs. Despite the fact that it is not aimed to do so, it may expose individual shortcomings, in which case ESMA will issue the necessary recommendations.
7. The exercise covers 16 CCPs, including all authorised EU CCPs and the three UK CCPs.
8. The first exercise conducted by ESMA was focused on the counterparty credit risk that EU CCPs

would face as a result of clearing member defaults and simultaneous market price shocks. The second stress test conducted by ESMA introduced several methodological improvements as well as incorporating an assessment of liquidity risk. This third exercise extends even further the coverage by including a new concentration risk component, that will be used to assess the losses arising from the costs of liquidating concentrated positions. The design of the new component is discussed in detail in section 3.5 and the results in section 4.5.

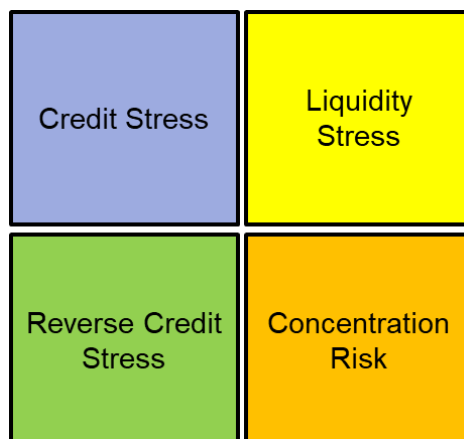
9. Counterparty credit risk, including the concentration risk assessment, and liquidity risk are the core types of risks faced by CCPs and the methodology has now evolved with targeted improvements. Relevant residual limitations are highlighted and analysed in the report. It should be noted that CCPs are also subject to other types of risks that are either not covered or are partially covered and could in isolation or in combination with credit and liquidity risks challenge their resilience. In particular, operational, legal and any type of business risks have again been left outside the scope of the exercise, because of their largely idiosyncratic nature and may be considered in future exercises.
10. As mentioned above, the compliance of the CCPs with EMIR is not part of the exercise and it is actually assumed and taken as one of the starting points of this exercise, as it is expected to be ensured through the supervisory process involving the National Competent Authorities and the Colleges. As in previous exercises, the stress test does not review, and is not be able to conclude on, whether individual CCPs meet the minimum regulatory requirements. Also, potential shortcomings in policies and practices of individual CCPs, such as for example in the operationalisation of default handling procedures can challenge their resilience but are beyond what is considered in the course of this exercise.
11. It should be noted that the exercise does not target all possible market movements, in particular the relative movements between each pair of assets. Indeed, while the architecture of the Stress Test is based on internally consistent scenarios, where N securities or contracts are cleared and possibly in the same portfolio, the number of possible basis risk movements is 2^N . The value of N is at least thousands in the case of an equity clearing service and thousands for derivatives. This makes it impossible to apply all the potentially damaging scenarios across all CCPs' portfolios. The risk arising from adverse relative movements between individual assets is therefore outside the scope of this exercise.

3 Methodological Overview

3.1 Design and Components

13. This stress test exercise has the following components:

- **Credit Stress:** Assess the sufficiency of CCPs' resources to absorb losses under a combination of market price shocks and member default scenarios.
- **Liquidity Stress:** Assess the sufficiency of CCPs' liquid resources under a combination of market price shocks, member/liquidity provider default scenarios and additional liquidity stress assumptions.
- **Concentration risk:** Assess the impact of liquidation costs derived from concentrated positions.
- **Reverse Credit Stress:** Increase the number of defaulting entities and level of shocks to identify at which point resources are exhausted.



Additional Analysis

- **CM knock on analysis:** Assess the impact of the loss sharing mechanism of CCPs (default fund contributions and power of assessments) on non-defaulting clearing members.
- **HHI concentration analysis:** Assess the degree of concentration of CCPs' credit and liquidity exposures using the HHI Index.
- **Inter-connectedness:** Assess the degree of inter-connectedness of CCPs through common clearing members, custodians or liquidity providers.

3.2 Overview of the Process

14. The key steps needed for the implementation of the exercise are summarised in the following figure and discussed in the following paragraphs.



FIGURE 1: OVERVIEW OF THE PROCESS

15. ESMA published in April 2019, the framework for the 3rd CCP Stress Test Exercise¹, setting out the scope, an overview of the methodology and the expected deliverables. The ESRB provided the set of market stress scenarios that were specifically developed for the purpose of this exercise. ESMA defined the data request templates and provided the CCPs with detailed instructions on how they were expected to calculate and report the required data, especially concerning how they were

¹ https://www.esma.europa.eu/sites/default/files/library/esma70-151-2198_framework_for_the_2019_ccp_st_exercise.pdf

expected to translate the market stress scenarios to P&L calculations for their own portfolios. In order to ensure close cooperation with all the relevant authorities in the design phase, a Stress Test Task Force² (STTF) was setup and contributed to the development of the framework, including the scenarios, the data request, instructions and the tests to validate the data received. Following the computation of the results, the STTF was also involved in the discussion of the preliminary results and in the process to reconcile them. ESMA also organised a workshop with the members of EACH subject to the exercise (EU CCPs) which were consulted on the overall framework and more specifically on the data request templates and the instructions.

16. The data request was launched on 4 April 2019 immediately after the definition of the Stress Test Framework, and the CCPs were requested to deliver in six weeks the completed data templates to the NCAs. The receipt of the files by the NCAs in May 2019 was followed by the first data validation phase, where the NCAs validated the submitted data against the instructions and according to a common set of validation rules that detailed the checkpoints and set the allocation of work across the participating authorities (i.e. NCAs and ESMA). The first data validation phase lasted 6 weeks. Each NCA appointed one officer that was the single point of contact. Where needed, the appointed officers were in contact with ESMA staff and fellow officers from other NCAs in order to facilitate the consistent implementation of the framework across all CCPs. Moreover, in order to facilitate the convergence of the validation practices across different authorities, ESMA staff compiled and shared with the authorities a list of frequently asked questions, together with the respective answers. The first validation phase was concluded with the delivery of the data templates in late June / early July 2019 to ESMA that acted as a second line of defence in terms of data quality assurance. Following the NCAs' validation, ESMA checked at least on a sample basis, that the reported data were consistent, reasonable and conform to the requirements included in the instructions. It finally assessed the overall plausibility of results, including a comparison between CCP results, to detect any outliers. The second validation phase was scheduled to last a total of 7 weeks. While the first set of findings were identified and addressed within this period, there were a significant number of issues that had to be followed-up multiple times, while in some cases, the correction of issues or the progress of the analysis raised new issues. Therefore, in practice the validation process continued in parallel with the analysis of the data that started immediately after resolving the first issues.
17. After having achieved the necessary progress in data analysis, the Task Force set the sensitivity parameters used in the concentration component in December 2019. ESMA calculated and analysed the results of the stress test. The preliminary results of the stress test were first discussed in January and March 2020 at the Task Force and then at the CCP Supervisory Committee in April and May 2020. As a final step, ESMA also reconciled in April 2020 the core stress results with each individual CCP via the relevant NCA, in an effort to reconfirm their robustness. The reconciliation exercise was focused on CCP specific data. EU-wide data could not be reconciled without revealing confidential information on other CCPs or clearing members. Increased time and effort were devoted to the reconciliation process compared to the previous exercises, in order to ensure that the participants had the time and information needed to confirm the interpretation of the sourced data and the correctness of the results. To take into account the constraints of the COVID-19 pandemic, the launch of this reconciliation exercise was delayed by two weeks and when launched, three weeks were given to CCPs, compared to one week allocated in the previous exercise.

⁴ Participants of the Task Force included experts from National Competent Authorities (NCAs), representatives from other Competent Authorities in the Member States, one representative from ESRB and one representative from ECB. The ESRB participation facilitated the coordination of the input from the ESRB on the price shock definition, while the ECB involvement was particularly relevant for the design of the liquidity stress test.

18. It must be noted, that ESMA staff lacked the resources, detailed knowledge of specificities of products cleared, and direct access to the CCPs in order to redo all the validation checks that have been performed by the NCAs. This also applies regarding checking the details of the modelling procedures employed by each CCP for product-level valuations or conservative propagation of shocks in the forward curve. Therefore, to a significant extent, the quality of the data and results still rely on the data submitted by the CCPs and the primary checks performed by the NCAs.

3.3 Market Stress Scenarios

19. As in the 2017 exercise, the ECB, in close collaboration with the ESRB and ESMA, has developed the narrative and has calibrated the adverse scenario for the 3rd stress test exercise. The shocks were produced using the tool that is employed for the calibration of financial shocks in the stress test design framework for adverse scenarios at the ECB and has been in use for the calibration of financial shocks for the EBA, EIOPA and ESMA stress test scenarios starting from 2014. The scenario that was produced reflects the ESRB's assessment of prevailing sources of systemic risk for the EU financial system at the time of its design³. It reflects the triggering of one or more of the sources of systemic risk to the EU financial system identified by the ESRB. These risks could materialise jointly and reinforce each other. The triggering variables include swap rates, sovereign bond spreads and equity prices. The results are derived using a methodology that considers the joint empirical distribution of historical observations of the risk factors deemed relevant to EU CCPs to produce a coherent joint scenario. The scenario is obtained by choosing the mean response of the conditioned variable in an adverse scenario for the triggering variables with a joint probability of 0.1% over a five-day horizon. The starting point of the sample is 2004 and the shocks were produced for more than 800 risk factors across different asset classes.
20. It is important to note that the EU-wide stress scenarios should not be bound to only replicate past historical scenarios, but also use past observations in combination with a narrative that reflects the assessment of prevailing sources of systemic risk for the EU financial system to produce shocks that model potential future market conditions.

BOX 1: NARRATIVE OF THE SCENARIO AS PROVIDED BY ESRB

The translation of the sources of systemic risk identified by the ESRB into concrete instantaneous shocks following triggers initiated in various market segments is described below.

The main trigger of the adverse scenario is a disorderly increase in risk premia as a result of increasing global political and policy uncertainty against a backdrop of high asset valuations. The abrupt increase in global risk premia would translate into a modest steepening of swap curves and a large fall in other asset prices, which would be amplified by a general sell-off of stocks by the non-banking sector. A general repricing of risk premia would also bring about a repricing of sovereign spreads, especially in the EU, where ratios of private and/or public debt to GDP in many countries remain well above the sustainability thresholds suggested by the literature. Yields would also increase on non-financial corporate bonds following the generalised increase in risk premia. This would be reflected in an overall negative impact on global investment and global demand for raw materials, causing a sharp downward movement in commodity prices.

³ The scenario was finalised in March 2019.

The scenario is obtained by choosing the mean response of the conditioned variable in an adverse scenario for the triggering variables with a joint probability of 0.1% over a five-day horizon. The sample chosen for the calibration spans from January 2004⁴ to December 2018. Due to data quality issues, an overlay has been added for a few risk factors concerning commodities to align the calibration with the 5-day historic minima.

21. The exercise needs to assess the resilience of EU CCPs to a potentially unprecedented crisis. Consequently, should we have restricted to only replicating past historical shocks on the basis of minimum regulatory requirements, we could have missed a wide range of stress events with no historical precedent, especially for new products / risk factors with short lookback periods. Overall, it is a very difficult task to produce potential future scenarios for such a wide range of financial variables covering all major asset classes, which are at the same time sufficiently severe, internally consistent and plausible. The methodological tool used can combine a large number of time series and has allowed for the calibration of a more granular scenario, covering more than 800 risk factors. There is no single test that can ensure that all variables are jointly sufficiently severe and plausible.
22. The overall severity of the shocks was compared with the severity of shocks used for past CCP supervisory stress tests, including the previous EU-wide CCP stress exercises and was found to be overall comparable. Having said that, there are cases where the shocks are more/less severe. Moreover, the increased granularity of risk factors allowed to differentiate between risk factors within one asset class and produce shocks that are more/less severe for individual risk factors if compared to the “blanket” shock used in the previous exercise.
23. At the time of calibrating the market stress scenarios, the magnitude of the shocks was also compared for key risk factors with the maximum historical shocks over a long lookback period. The shocks were found to be neither overly severe nor implausible. Overall, the shocks were found to be below the maximum historical 5-day changes for the key risk factors considered and overall below or above the 2-day worst historical shocks. In many cases, it makes a big difference if one would consider the full available history or only more recent observations. Of course, the “full-history” shocks may be more severe but may also include observations from a structurally different environment (e.g. higher rates or lower commodity prices).
24. The Regulation mandates ESMA to assess on an EU-wide basis the resilience of CCPs to adverse market developments. This EU-wide assessment is not necessarily to be restricted by the minimum regulatory requirements that set the minimum level of severity of the shocks that are used by individual CCPs in their own stress tests. The purpose of the stress test is not to assess the compliance of CCPs to the minimum regulatory requirements but assess their resilience to macro-economic scenarios that can have an EU-wide impact and the ESRB is best placed to do so.
25. During the time of finalisation of the exercise, the Covid-19 outbreak led to sharp and extreme market movements for instruments across the majority of asset classes. A brief analysis of the stress scenarios in the light of the Covid-19 outbreak market moves is presented in Box 2. It should be noted that the EU-wide Stress Test cannot be used to assess the resiliency of CCPs under specific historic events, but rather aim to assess the resiliency of CCPs to adverse market movements on a forward-looking basis. This is why the stress scenarios are not bound to replicate past market movements but are rather calibrated to model hypothetical future potentially disruptive scenarios. Nevertheless, it is useful to understand how the market shocks experienced during the Covid-19

⁴ The model uses daily data and the majority of time series have sufficient data as of 2004.

outbreak compare with our stress scenarios in order to understand if the scenarios are relevant and have proven to be overall of comparable severity with historic and the most recent stress events.

BOX 2: THE MARKET STRESS SCENARIOS IN THE LIGHT OF THE COVID-19 OUTBREAK

The global markets experienced in March 2020 extreme movements across the majority of asset classes. In several cases the movements were more severe than what was experienced during the peak of the 2008 credit crisis and even comparable to the maximum historical movements.

An overview of the evolution of the market moves for benchmark products during the first days of the market turmoil is presented in the following figure. An arrow is shown on a date if the 2-day move (ending on that date) was 'high'⁵, with the colour and direction of the arrow indicating the direction of the relevant move.

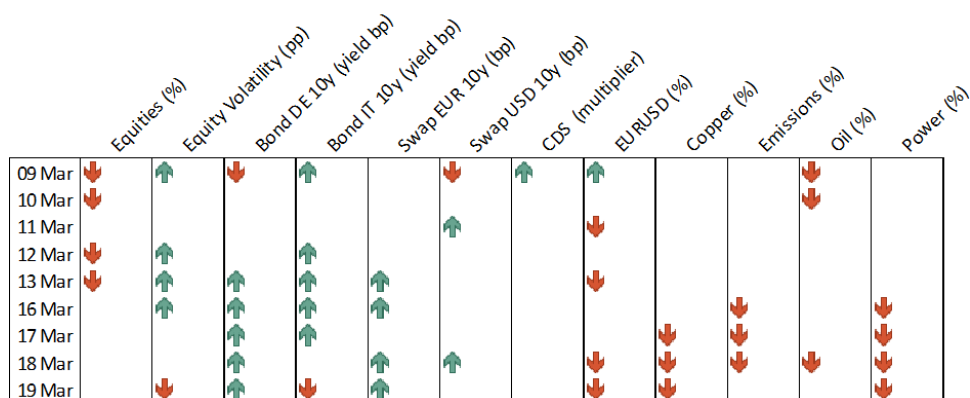


FIGURE 2: EVOLUTION OF 2-DAY MOVES FOR BENCHMARK PRODUCTS DURING THE FIRST DAYS

The start was an abrupt downward shock in oil prices combined with an extremely sharp decrease in Equity prices and a widening of credit spreads that quickly led to a repricing of the yields in bond markets and a steepening of the swap's curves. In the light of fears for a global recession, commodity prices fell with extreme volatility manifesting itself also in power markets.

The extreme market movements led to a sharp build-up of losses for many market participants, combined with margin calls from CCPs issued to collateralise the increasing exposures, also on an intraday basis. Despite the extreme pressure, the CCPs in scope of the exercise did not experience any clearing member defaults.

In the context of risks linked to the clearing activity, a combination of clearing member defaults and simultaneous extreme market moves are needed to put a CCP at risk. In principle, if clearing members continue to post margin and meet their obligations, periods of extreme market volatility in isolation will not pose a specific market risk to a CCP. Moreover, the clearing members are required to collateralise on a daily basis their exposures and thus, the market risk is limited to the potential price movement from the last collateralisation of a defaulter's position until the time needed to hedge or close-out the position. Therefore, in terms of market movements, and always in combination with simultaneous defaults, it is generally the extreme short-term shocks

⁵ i.e. higher than 50% of the period maximum.

spanning over a period of a few days that may put a CCP at risk and not medium or long-term market movements building-up over a longer period.

The scenarios used in this stress testing exercise are overall direction-wise comparable to what was observed in the market over the last months. As expected, this is not the case on a day-by-day basis, but overall after the first day it seems that the scenario modelled reasonably well the actual overall co-movements between different asset classes. However, this does not mean that we have tested all co-movements between different asset classes and especially between individual risk factors as observed in the market.

We compared the EU-wide stress scenario shocks with the experienced market movements for a number of benchmark products across all asset classes. We have used the maximum of 1-day & 2-day moves over the period for all benchmark products with the exception of the primarily OTC-traded instruments (i.e. CDS and Swaps) for which we have used the maximum of 1-day, 2-day & 5-day⁶ moves. This choice was made to reflect the EMIR requirement in terms of the minimum number of days that the CCPs need to consider when calculating the margin requirements for the different instruments. It should also be noted that this analysis compares the shocks of the internally consistent stress scenario with the maximum moves observed during an event that unfolded over multiple weeks. Not all maximum moves happened on the same days and these could not have hit even a single CCP at the same time. However, we are not considering any second-round effects that could have amplified the market moves in case a default would have happened.

The comparison of the scenario shocks with the maximum market moves showed that our scenarios are of comparable severity with what was observed in the market with only a few exceptions, mainly Oil, CDS and in some cases also Power. For Equities, FX, Bonds and Swaps the scenario shocks were, with the exception of only a few outliers, of higher intensity. With regards to Commodities, the scenario shocks for Metals (Industrial & Precious), Emissions and Natural Gas were also of higher intensity. However, for Oil we noted market moves that were significantly more severe, reaching levels that were overall close to 50% higher than the contemplated scenario shocks and for some individual contracts even higher⁷. Also, for some power markets we saw moves that were on average 30% more severe, if compared with the relevant scenario shocks. Finally, for CDS the spread moves for benchmark indices were in all cases higher than the scenario shocks, with the average move being approximately 75% more severe than the scenario shocks.

While being cautious about the uncertainties resulting from any attempt to conduct a comparison of this kind, we have analysed the impact of using scaled-up shocks in the credit stress test results for default funds where CCPs clear such products. This analysis cannot lead to accurate and robust conclusions as different risk factors within broad asset classes exhibited different behaviour, whereas in our blanket approach the shocks are uniformly scaled up for all risk factors within one asset class, based on a rough estimate of their overall relative severity⁸. Having this

⁶ At the time of the analysis it was identified that including the 3-day and 4-day moves for OTC would not change materially the conclusions.

⁷ After the first two weeks of very extreme price moves that were acknowledged in the analysis and as the crisis evolved, negative prices were noted for an Oil contract heading to delivery accompanied with unprecedented price changes. Moreover, the lower price levels led to what was observed as very high % moves across multiple contracts. This is not reflected in the analysis.

⁸ As an example, we have calculated the relative severity for CDS by averaging the shocks and the market moves across different indices. Individual single names or subsets of indices have shown different behaviours if compared to the stress shocks.

in mind, we have used the x1.5 shocks for Oil & Power and the x2.0 shocks for CDS. The estimated impact from assuming these sharply increased shocks would be limited, leading only to one or two very small marginal shortfalls, in all cases of no systemic relevance. This analysis cannot be used to draw any conclusions on how the CCPs would have been impacted if there had been a default during this period of extreme volatility, as this would have foremost required a) to consider the actual positions held in March 2020, instead of the positions of our two stress test reference dates, and b) to take duly into account the specificities of each CCP's products and risk factors. The stress tests that are run daily by CCPs are better placed to assess the impact of historic market moves on corresponding historic positions taking fully into account specificities of cleared products. The EU-wide Stress Test aims to assess the resiliency of CCPs to adverse market movements on a forward-looking basis. It cannot be used to draw conclusions on the resilience of CCPs to specific historic events, as this would require the exact replication of historic exposures and eventually any conclusions drawn would be bound to a specific historic event of the past, with limited explanatory power for future events.

To conclude, the scenarios that were used to run the EU-wide CCP Stress Test are overall of comparable severity to the overall actual market events in March/April with only limited exceptions. This comparison confirms that the adverse scenarios have indeed been calibrated to extreme levels. The scenarios can be used to assess the resiliency of CCPs under hypothetical extreme but plausible market movements. However, one needs to be very careful when drawing conclusions, as the EU-wide Stress Test is subject to a number of limitations and assumptions. Moreover, as the COVID-19 crisis unfolds additional extreme moves may be experienced and the CCPs need to be prepared to mitigate the resulting risks.

3.4 Methodology – Credit Stress Test

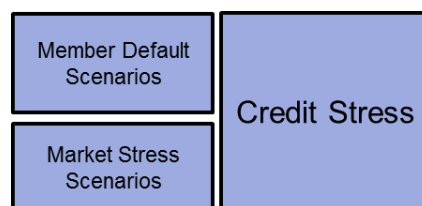
3.4.1 Overview

26. The credit stress test assesses the sufficiency of CCPs' resources to absorb losses under a combination of market price shocks and member default scenarios.

27. The CCPs reported, for each one of their members and for each date separately, the losses the CCP would face if a member would default following the market shocks dictated

by the common Market Stress Scenario and the resources that would be available to cope with the default. In order to ensure, as much as possible, the consistent implementation of the common scenario, ESMA developed and provided together with the data request a set of detailed instructions. The instructions set the rules on how the market scenarios are expected to be implemented and in particular, how the CCPs will need to translate the risk factor shocks into P&L for their cleared products and the available collateral. An overview of the rules, with a focus on the improvements compared to the previous exercises, is provided in paragraph 3.4.3.

28. After receiving the exposures of each CCP towards each clearing member, ESMA applied the conditions and assumptions underlying the Member Default Scenarios in order to identify the groups of clearing members that are assumed to be in default. The groups with the top exposures were identified by aggregating the losses across clearing members and, where relevant across CCPs (i.e.



for the EU-wide member default scenario). A detailed description of the member default scenarios and the underlying conditions is provided in the following paragraph (3.4.2).

29. In all cases, the credit stress test results are a combination of the common market stress scenarios and one of the member default scenarios. The results are reported in terms of losses compared to the resources that were available to cope with the default and are subject to the assumptions and limitations as these are described in paragraph 3.4.4.

3.4.2 Member Default Scenarios

30. The member default scenarios define the conditions that are used to select the entities that are considered to be in default. We have reduced the number of member default scenarios compared to the previous exercises, in an effort to focus on scenarios that are more informative and avoid scenarios that may be deemed as unrealistic⁹. The following scenarios were employed:

- **Cover-2 groups per CCP:** For each CCP, we select as defaulting entities the members belonging to the top-2 (corporate) groups of clearing members for that particular CCP. The defaulting clearing member groups are selected per CCP, hence they may be (and in most cases are) different for each CCP and they are not considered to be in default in other CCPs. When a group is considered to be in default in one CCP, all clearing members that belong to the identified corporate group are assumed to default for the same CCP.

The groups that are selected for each CCP are the ones that lead to the highest aggregate (EUR) loss beyond required margin collateral of the defaulter and beyond the Default-Fund-level prefunded mutualised resources, including the Default Fund, the “Skin-in-the-game” and other prefunded Default-Fund-level resources. Thus, the selection process will identify the two groups that could together lead to a depletion of the prefunded resources. If such pairs of groups are not to be found (i.e. no shortfall of prefunded resources following the default of two groups), we select the two groups that would lead to the highest consumption, measured by the aggregate (EUR) loss beyond Required Margin at a CCP level.

Where there is no shortfall of prefunded resources, we have explored using as a selection measure the largest percentage (%) consumption of resources¹⁰. This selection would put more focus on smaller default funds and lead in some cases to higher maximum % consumptions, but also lower aggregate (across default funds) EUR losses over margin. This impact is discussed when presenting the results as it may highlight a higher sensitivity in a smaller default fund. Moreover, we have also explored using as an alternative fall-back condition (i.e. if no shortfall of prefunded resources), the largest aggregate (EUR) loss beyond Required Margin & defaulter’s Default Fund Contribution. This selection looks for groups that maximise the impact to non-defaulting clearing members, but the results were similar and are thus not reported.

The “Cover-2 groups per CCP” scenario focuses on pairs of groups that are most relevant for each CCP but includes the rather unrealistic assumption that the same entity would default in only one CCP. The EU-wide scenarios, where we select the top-2 groups EU-wide, cannot be

⁹ As anticipated also in the framework, we are not using the former “MD-A” member default scenario, where we first assumed the default of the top-2 members per CCP and then assumed the default of all these top-2 members in all CCPs. The experience from the previous exercises showed that this scenario led to an extremely large, rather unrealistic number of entities defaulting at EU-wide level.

¹⁰ i.e. % consumption of resources in any Default Fund, including Default Fund, “Skin-in-the-game” and other prefunded Default-Fund-level resources

used to assess the resilience of individual CCPs, as the selection algorithm will always focus on the two most EU-wide systemically important groups and may fail to highlight shortfalls for individual CCPs. Therefore, the inclusion of this member default scenario is important in order to allow the assessment of the resilience of individual CCPs.

- **EU-wide Cover-2 groups¹¹**: Across all CCPs (EU-wide), we identify the two (2) clearing member groups with the highest aggregate exposure under the specific market stress scenario. All clearing members that belong to an identified corporate group are assumed to default simultaneously across all CCPs. Under this scenario, there may be CCPs with no clearing members defaulting, if none of the defaulters identified at the EU-wide level is a member at these particular CCPs. This scenario will give an aggregate view of the impact of the default of two groups of clearing members in the EU.

With regards to the exact condition used to select the clearing member groups, the first choice is to select the top-2 groups that would lead to the highest aggregate shortfall of prefunded resources across all CCPs, i.e. select the two groups that lead to the EU-wide highest aggregate (EUR) loss beyond Required Margin and beyond the DF-level prefunded mutualised resources, including the Default Fund, the “Skin-in-the-game” and other prefunded DF-level resources.

However, as we have also again seen in previous exercises, this selection condition just focuses on a shortfall for one CCP (that is already presented under the cover-2 groups per CCP scenario) and propagates to all other CCPs the default of the same two clearing member groups with no significant additional impact. The results using this selection condition are reported since they are useful to see what would happen at an EU-wide level as a result of the default of the two Groups leading to a shortfall at one CCP. It would however fail to adopt a more systemic point of view, as for example by exploring the default of pairs of groups that would put simultaneous pressure on multiple CCPs. Therefore, instead of only trying to maximise the shortfall, we are also reporting the results after selecting the groups that lead to the highest aggregate (EUR) loss beyond Required Margin across all CCPs¹².

31. In all cases, the defaulting members are selected for each stress date individually and considering the relevant exposures. Central banks, governments and CCPs are not included in the list of entities that may be assumed to be in default for the purpose of this exercise. Moreover, when selecting the defaulting members, we always use only the required margin, i.e. excluding any margin provided in excess of the minimum requirement.

3.4.3 Calculation of Credit Stress Exposures

32. The set of common market price shocks were run by individual CCPs in order to determine the exposures towards their clearing members. Given that it was not feasible to define scenarios for each and every risk factor of all CCP-cleared contracts, the scenarios were defined for a large number of risk factors across different asset classes and the CCPs needed to use the risk factor shocks to calculate the P&L for their cleared products and the members’ portfolios. We have therefore developed and provided together with the data request and the market stress scenarios a set of detailed instructions that set how the calculations are to be performed. The instructions were drafted to provide clarity and address all material implementation challenges.

¹¹ The “EU-wide cover-2 groups” member default scenario was called “MD-B” in the previous exercise. The name changed following the removal of the “MD-A” scenario.

¹² We have again explored using an alternative metric to maximise the overall Impact, i.e. the largest aggregate (EUR) loss beyond Required Margin & own Default Fund Contribution. The results were found to be similar and are thus not reported.

3.4.3.1 Stress Dates and modelling of the Default

33. The credit stress test was run for two reference dates, for all CCPs. The exercise was run on the basis of one common market stress scenario and this has allowed us to use two stress dates and keep the overall required effort for all participants manageable. Therefore, the results are not dependent on the positions and resources for only one single date. Positions can change significantly from one day to the other triggering margin changes, while also mutualised resources are resized by CCPs on a regular basis. Also, on an outcome basis, we have seen that the results differed significantly between the two dates.
34. The selected stress dates are Friday, 21 December 2018 and Friday, 8 March 2019. The dates were selected in order to reflect in the results of the exercise credit / liquidity exposures from expiries in equities and fixed income derivatives. The default event is modelled as a weekend default. Therefore, all payments/obligations due on Friday are assumed to be met in full. After the default (which occurs during the weekend), no payments are exchanged between the CCP and the defaulting member. Trading access is assumed to be revoked during the weekend, so that no position changes are accepted after the last novation cycle of Friday. The positions therefore reflect the positions as of Friday end of day, including all transactions that were accepted for novation during Friday.
35. It is assumed that no porting of clients will occur, hence clients' portfolios are covered along with the proprietary positions of the defaulted clearing members and any losses resulting from clients' positions are included in the reported results. In the context of the credit stress test exercise, this is a conservative assumption as the margin allocated to client accounts can anyway not be used to cover losses of other client or proprietary accounts of the clearing member.

3.4.3.2 Calculation of stress P&L from closing the Positions

36. All positions are assumed to be closed, for each individual account, at the prices implied by the provided market shocks. All price movements are supposed to be happening instantaneously at the time the defaults are announced. Therefore, the prices on the Monday morning following the default are already assumed to reflect fully the price shocks and no further price moves are assumed to occur.
37. The CCPs were instructed on how to identify or adjust when needed the shocks to be applied to their own products using the provided risk factor shocks and how to calculate the P&L stemming from those shocks. Specific rules were provided per product type or asset class to set how the shocks were to be adjusted, e.g. for similar underlyings or different maturities. For a few assets (e.g. dividend derivatives) for which no relevant risk factor has been provided, the shocks were to be modelled by the CCP using the stress scenarios used for their default fund sizing under the supervision of the NCA.
38. As a general rule, CCPs needed to operate a full repricing on the basis of the risk factor shocks and using the pricing models they normally use for the daily valuations of positions. Wherever they are available, the CCP needed to use actual market prices for the base price, i.e. the price to which the shocks are to be applied. Model-implied prices were only to be accepted where market prices are not available or not reliable.
39. Beyond the exposures using the common market shocks, the CCPs were asked to report the exposures as well after applying a number of multipliers on the shocks (i.e. x0.7, x 1.2, x1.5 and x2.0). Each value of the multiplier corresponds to a Reverse Stress Scenario and all shocks are to

be simultaneously scaled. For each value of the multiplier, the CCPs ran a full repricing of the portfolios, as opposed to applying a multiplier to the result (P&L) of the scenario.

40. In the determination of losses, no hedging strategy was allowed to be acknowledged or modelled. In other words, the CCP is assumed to not have performed any risk mitigating transactions in order to limit the risk of the defaulting member's positions, but it will liquidate all the defaulting member's positions at the stressed price and will not introduce additional transactions such as an index trade to capture first order risk.
41. The stress loss reflects the amounts that should have been paid by a defaulting member if it had not been in default on Monday morning, e.g. a loss due to actual market movements on Friday that is to be settled on Monday. It reflects the full amount that the CCP would collect / pay in case of the default, i.e. not only the profit or loss due to the stress shocks, but also any accumulated profit or loss that has not been settled until Friday end of day and will have to be settled when closing the position.
42. The CCPs were asked to report data at member (and not account) level in order to limit the amount of data. The CCPs were however required to reflect in the reported amounts all applicable segregation rules, e.g. that client's resources cannot be used to cover losses from proprietary positions.
43. Beyond the use of two dates, the methodology of the credit stress test component has also evolved to cover additional risk sources, including the revaluation of collateral using the stress scenarios and an assessment of the wrong way risk linked to a clearing member or affiliate being issuer of instruments it assumes for clearing. These are described in detail in the following paragraphs.

3.4.3.3 Adjustment for Wrong-Way Risk

44. One of the improvements incorporated in this exercise is the inclusion of a wrong-way risk adjustment for cleared positions. In the previous exercises we did not consider the effect that the default of specific entities (e.g. clearing members) would have on the price of related instruments, i.e. instruments issued by the defaulting clearing member or by one of its affiliates (or having as underlying an instrument that is issued by the defaulting clearing member/affiliate).
45. Therefore, the CCPs were instructed to incorporate, in the P&L calculations for each member, this effect for all cleared instruments issued by this specific clearing member or its affiliates. This adjustment affects securities, corporate debt, covered bonds, derivatives on securities/debt and single-name CDS's. Index products are left out of scope for avoiding complexity. CCPs were given a fixed, common recovery rate and were instructed how to reflect it in the price of the impacted instruments. The CCPs were asked to apply this adjustment, only when the net effect (for all instruments within one clearing member) is negative, i.e. when the wrong-way-risk adjustment for the clearing member resulted to a loss¹³.
46. When assuming that an entity is in default, one should ideally have reflected this in the price of the cleared instruments for all clearing members and all CCPs. However, as acknowledged during the design phase of the exercise, this was not possible using the current setup because the P&L is first calculated by the CCPs using the common markets stress scenario, while the selection and identification of defaulting entities is only performed after the submission of the data. Hence, one of

¹³ This condition to only adjust where the result increases the losses introduces a degree of inconsistency, but was identified as a prudent way to mitigate the modelling uncertainties (e.g. recovery rate) having in mind cases where a short position in an instrument issued by an affiliate of the clearing member would lead to a profit.

the residual limitations is that we could not have modelled the effect from the default of all entities, e.g. when we assume the default of two clearing members, we will only have for each clearing member the effect from instruments issued by itself and not for instruments issued by the other clearing member.

47. This treatment for wrong-way risk exposures is a first positive step towards the direction of incorporating a fully-fledged wrong-way risk adjustment, but the scope is somehow limited. Similarly, any wrong-way risks towards issuers & custodians of collateral and other resources are also not acknowledged in the context of the credit stress test component. The key problem with accounting for these risks is that in practice it may depend on each CCP's rules whether the relevant credit risks will be covered by the default waterfall, the CCP itself or the clearing member providing the collateral. Therefore, it is difficult to model consistently across CCPs in an exercise of this scale.

3.4.3.4 Default Waterfall and Collateral

48. CCPs collect margins, default fund contributions and keep dedicated own resources that can be used to cover losses stemming from a clearing member's default. The scope and priority in use of the different resources are set in regulation and the rules of CCPs. A typical default waterfall is presented below, only for illustration purposes. The actual default waterfall of each individual CCP, as this was reflected in the data reported, has been considered to calculate the absorption of losses in the EU-wide CCP stress tests.

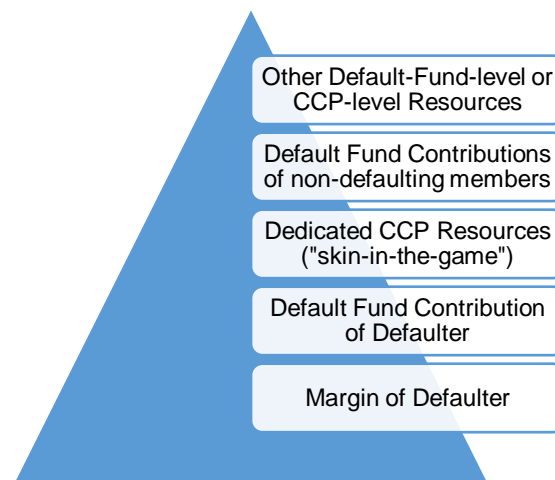


FIGURE 3: ILLUSTRATIVE TYPICAL DEFAULT WATERFALL

3.4.3.5 Identification of Collateral

49. Concerning the default fund contributions, the reported amount reflected the required amounts, i.e. no excess collateral reported for the default fund contribution. In terms of margin, the CCPs were asked to report separately the minimum required collateral, not including any excess amounts, and the total available collateral.
50. The minimum required collateral is meant to reflect a scenario where defaulting members would have withdrawn under stressed conditions any collateral exceeding the minimum required. In fact, any member experiencing financial difficulties would most probably post only the minimum required collateral. Nevertheless, the CCPs have been asked to report also the actually held (total available) collateral, including excess amounts. Therefore, although the base stress results will only consider

the required collateral, for completeness reasons we also present in some cases the stress test results using the excess collateral. In order to make the two sets of results (with / without excess) directly comparable, the same defaulting entities will be considered and in particular, the defaulting entities will always be selected using the minimum required collateral without the excess.

51. The required margin was identified as the sum of the margins required to be paid on Friday morning, any payment issued and paid during Friday as a result of margin calls and any of the collateral previously held as excess but consumed by the member's activity or intra-day valuations during Friday and offset against the computation by the CCP of margin requirements during Friday, the absence of which would have led to a margin call according to the CCP's existing rules and procedures.
52. In this exercise we have also updated the templates to allow the CCPs to report the amount of surplus house margin collateral, i.e. any part of the minimum required margin collateral for house accounts that is left unused after covering the losses in one default fund and can be used to cover losses for the same member in another default fund of the same CCP. In all cases, only CCPs that explicitly allow in the rules setting the default waterfall, the usage of defaulter's collateral across default funds were allowed to report such amounts. The fact that this amount was reported separately, allowed us to quantify the impact. The impact of not considering this has been found to be limited. It would not change the conclusions and thus in all cases only the results after accounting for this surplus margin are presented¹⁴.

3.4.3.6 Valuation of Collateral

53. A significant methodological change incorporated in this exercise is that the CCPs are asked to revalue the collateral alongside the cleared products using the market stress scenarios shocks. We will therefore not rely on the haircuts applied by CCPs.
54. In the previous exercises, we used for the credit stress test the collateral requirements, i.e. the post-haircut value of collateral that had to be provided by clearing participants. Also for excess collateral, CCPs were instructed to report separately the excess value after accounting for the haircut. Therefore, one of the underlying assumptions was that the CCPs could realise the actually posted collateral at least at its haircut value.
55. Although in principle, this valuing collateral using the same stress shocks improves scenario consistency and gives us the ability to check haircut adequacy, it is not necessarily in all cases the most conservative choice. For example, it can be that the collateral value increases following the shocks, while when relying to (CCPs') haircuts the collateral value is always reduced. Moreover, in practice it may depend on each CCP's rules whether the market risk from stress P&L beyond the applicable haircuts should be covered by the default waterfall, the CCP itself (e.g. through its own capital) or the clearing member providing the collateral (e.g. through a call for a non-defaulting clearing member to replenish its default fund contribution if the collateral provided for that purpose is valued below the haircut value). To make things even more complex, the CCP may have re-invested the actually provided collateral and the P&L from the actually available resources may be different (higher or lower) than the P&L from the provided collateral.
56. In order to account for this complexity, the following modelling assumptions were used. The CCPs were asked to report and use for the credit stress component the stressed values of margin & default

¹⁴ When calculating the results, the surplus house margin collateral was allocated to the other default funds (always for the same member within the same CCP) pro-rata.

fund collateral actually provided by clearing members (as opposed to the stressed values of relevant resources following re-investment). This implies that any market risk P&L for such collateral beyond haircuts would affect the default waterfall. CCPs reported and used for the credit stress component the stressed values of “skin-in-the-game” and own resources corresponding to own resources, including “other prefunded resources” but excluding resources meant to meet minimum capital requirements. Since the credit stress test is based on the provided (as opposed to invested) collateral, any market risks stemming from the re-investment of collateral are not reflected in the exercise.

3.4.4 Residual Limitations of Credit Stress Test

57. As in all exercises of this scale and type, there are residual limitations. All positions are closed at the stressed market prices. The credit stress test component does not account for any additional losses due to the market impact or other related costs, e.g. auction premium, following the liquidation of the position. The impact from the liquidation of the position is assessed in the new concentration risk component.
58. Investment risks, including credit risks arising from the default of an issuer or custodian of collateral or other resources are not assessed in the exercise. The exercise does incorporate an assessment of the market risk for provided collateral using the common market stress scenarios. Any additional market or credit risks resulting from the re-investment of provided collateral are not covered. These limitations are due to the fact that these risks are linked to the individual actions and rules of the CCP and are thus difficult to model consistently across CCPs.
59. The wrong way risk that would materialise if one defaulting clearing member clears instruments issued by another defaulting clearing member. This limitation is due to the fact that the selection of which combination of clearing members are assumed to default needs to be performed after collecting the stress exposures. Moreover, in the interest of avoiding complexity, the wrong-way risk effects on cleared index products are not modelled.
60. Operational risks, including those that may lead to increased credit risks, such as the operationalisation of default procedures, are also out of scope of the EU-wide stress test exercise. These are considered idiosyncratic in nature and thus difficult to model consistently across CCPs.
61. Any additional second round effects to prices following the default of entities will not be modelled (i.e. the price shocks are the ones provided by the ESRB and the number of defaults are the ones described above, but the two are taken exogenously). Also, the default of additional entities due to losses accumulated from non-cleared portfolios will not be modelled because the scope of the exercise is limited to CCPs exposures. The potential of second round effects to non-defaulting members via the risk-sharing mechanism of CCPs (e.g. default fund and powers of assessment) will be assessed as part of the additional analysis (CM knock on analysis), but only the defaults implied by the member default scenarios will be considered when testing the sufficiency of the resources.
62. When modelling the scenarios and credit exposure, it is not possible to cover all possible risk factors and then all possible combinations of risk factor shocks for all CCPs. That would require modelling several thousands of risk factors and then all their co-movements. Since the exercise has to be run on the basis of common methodology and criteria, it cannot be aimed to identify topical deficiencies of individual CCPs. This includes for example the change of spread between two markets. Moreover, the shocks are modelled using a very large but still limited number of risk factors. CCPs’ models are in most cases more sophisticated and cater for additional sources of risk, such as jump-to-default-

risk for CDS.

3.5 Methodology – Concentration Stress Test

63. For the purpose of this exercise, the market illiquidity (or concentration) risk is the added cost of liquidating in the market a position (or hedging it) in a short amount of time (in practice the time allocated to the management of a default by a CCP).
64. As part of the credit stress scenario initial market shocks apply to the mid-price of all positions regardless of their size and direction. However, it is likely that CCPs would incur costs beyond this price, depending on the size of their positions and the depth of their markets.
65. Under the Article 53(3) of the RTS (Commission Delegated Regulation EU No 153/2013), a CCP shall conduct a thorough analysis of the potential losses it could suffer and shall evaluate the potential losses in clearing member positions, including the risk that liquidating such positions could have an impact on the market and the CCP's level of margin coverage.
66. Under the 2017 CPMI-IOSCO report (*Resilience of CCPs: further guidance on the PFM*), a CCP's margin model assumptions should incorporate estimates of market liquidation costs, including bid-ask spreads not otherwise modelled in the price returns or explicit fees paid to trading platforms or liquidation agents. These market liquidation costs should also reflect the market impact of liquidation activity, when applicable. When a portfolio liquidation requires the disposal of concentrated positions or portfolios that are otherwise significant in terms of anticipated impacts on market liquidity in the relevant product, a CCP should contemplate the possibility that assumed market liquidation costs, such as bid-ask spreads or mid-market pricing, will not in fact be actionable or otherwise predictable in the face of an actual liquidation.
67. ESMA incorporated the above regulatory requirements in the design of this exercise.

3.5.1 Concentration modelling overview

68. This exercise does not model the whole default management procedure. More specifically, there is no attempt to factor in the impact of an auction which could lead to smaller or bigger concentration costs. Rather, we only assess the market impact of liquidating positions or setting up hedges.
69. The market impact can be broken down in two parts:
 - an exogenous factor which is the relative size of the bid-ask spread. Spreads would represent a cost even for small positions.
 - an endogenous factor, when positions are too large and cause the market to move against them (one can think of a forced liquidation). Market impact depends on the position size relative to the market depth, which is the ability of the market to absorb a substantial amount without materially impacting the mid-price.
70. Exogenous liquidity adjustment is of negligible importance for the world's main futures and currency markets, but more significant for other markets like credit or energy.
71. For large positions, market impact is usually much larger than bid-ask spreads.
72. In the context of a portfolio containing a single asset, e.g. an equity, the concept is quite straightforward. There is only so much the market can absorb in one day before the market price of the security moves in an adverse direction.

73. The importance of managing concentration risk was illustrated in a recent market event. Following the default of a clearing member on the 11/09/2018 at Nasdaq Clearing, it was assessed that its positions were too large to be closed in the market. The illiquidity of the positions made the final losses to largely exceed the mark to market losses prior to the default.

3.5.2 Evaluating the market illiquidity of a position

74. The absolute market impact (in EUR) of a position is assumed to grow faster than its absolute size. We further assume that the market impact (in bps) of a position is driven by its relative size and type.
75. In other words, the size of each position (or of its hedge) relative to the average daily volume (or such relevant parameter) is first computed. The market impact (in bps) is then interpolated using the relevant sensitivity table.

3.5.2.1 Calibration of the sensitivity tables

76. Each CCP was requested to provide sensitivity tables estimating the liquidation costs for the different asset classes it clears. Typically, for any given asset class or sub-class, the tables would give the cost (in bps or % market value) for executing trades that are x0.5, x1, x2 of the average daily volume (or average daily notional amount when relevant). From all the contributions received, we then built EU-wide sensitivity tables for each asset class.
77. Yet, methodological choices had to be made in order to calibrate the sensitivity tables, as the number of CCPs providing estimates varies widely across asset classes. As an example, only 2 CCPs clear metal commodity futures/forwards and freight derivatives, but 12 clear equities.
78. A first validation of the submission enabled to correct the largest outliers, often after having to clarify the requirements with the CCP. However, even after this first step, estimates provided by the CCPs remained very dispersed with the typical standard deviation of the order of the median. For example, the average market impact for one average daily notional of energy commodity futures/ forwards is 646 bps, the median is 398 bps and the standard deviation is 497 bps.
79. In order to mitigate the influence of outliers, and after consulting the STTF, it was decided to use the median contribution as baseline.

3.5.2.2 Definition of the reference volumes

80. ESMA requested CCPs to report the concentrated positions of each of their clearing members following prescribed aggregation rules (see section 3.5.3).
81. For each given aggregation level, each CCP also reported a common reference volume for all its positions. This reference volume is usually reported as an Average Daily Volume (ADV) for securities, and an Average Daily Notional Amount (ADNA) for derivatives.
82. For securities, the primary source for ADVs is the systematic internaliser data¹⁵ computed and published by ESMA.
83. In most other cases, the reference volume was set using the CCP's own submitted data, as they

¹⁵The "systematic internaliser calculations" data files can be downloaded from ESMA Website: <https://www.esma.europa.eu/data-systematic-internaliser-calculations>

reflect the markets the CCP can readily access and for which it has in place the operational arrangements to readily execute transactions.

3.5.2.3 Additional methodological choices

84. The sensitivity values are interpolated linearly by parts between 25%, 50%, 100% and 200% of the reference volume.
85. For positions far exceeding 200% of the reference volume, extrapolation assumptions have a huge impact. To avoid unrealistic estimates for larger positions (in relation to the reference volume), it was decided to extrapolate flat the market impact in basis points beyond the last point provided by CCPs (i.e. 200% of the reference volume). In other words, the total market impact will scale linearly with the notional but not quicker.
86. For credit and fixed income derivatives, note that this extrapolation was made for values beyond 500% of the reference volume (i.e. beyond the last point provided by CCPs for those asset classes).
87. In this exercise, positions smaller than 25% of the reference volume are not contributing to the concentration risk.
88. Fixed income derivatives follow a different methodology¹⁶. A hedging cost (as opposed to a liquidation cost) of the reported positions is computed using a limited number of hedging instruments.

3.5.3 Scope and aggregation rules

89. The concentration stress test has been run on a single date (8 March 2020) and is based on the same positions as reported by CCPs for the credit and liquidity part of the exercise.

3.5.3.1 Market Scope

90. The exercise focused on the following securities: equities and bonds and on the following derivatives: equity, fixed income, commodities, credit, freight and emission allowance.
91. To limit the overall complexity of this first exercise, other markets have been excluded on the following grounds:
 - Small volumes in CCPs (structured finance products, ETCs and ETN bond types, securitised derivatives, CFDs)
 - Highly liquid markets (Foreign exchange derivatives)
 - Complex sub-asset classes decided on a case-by-case basis to limit the overall computational complexity (volatility index derivatives, dividend derivatives, inflation and cross-currency swaps).

3.5.3.2 Aggregation and reporting of positions

92. Based on the instructions included in the framework, CCPs calculated the aggregated positions per

¹⁶ The Fixed Income methodology is described in more details in the Annex (section 6.4.2)

instrument/asset class for each clearing member without distinguishing between the internal positions of different client / house accounts.

93. The prescribed target granularity is based on tables of the annex III of the Commission Delegated Regulation 2017/583 on MiFID II, dealing with transparency requirements. This allows the use of average daily notional amounts computed for transparency as an input to the exercise.
94. The aggregation was based on the following high-level principles:
 - For securities, the positions are aggregated at the ISIN level.
 - For other derivatives, non-linear positions (e.g. options) are aggregated with linear positions (e.g. futures/forwards) using their delta. The market impact of liquidating volatility exposure is not part of this exercise.
 - Single stock equity derivatives are aggregated with the underlyings through the net delta at ISIN level. For the rest of derivatives, the aggregation follows class specific criteria and maturity buckets.
 - Fixed income and credit derivatives positions are reported through aggregated risk sensitivities.
95. To limit the data volume and focus on concentrated positions, CCPs have only reported relevant positions above class-specific thresholds.
96. To allow for a simpler implementation
 - the positions are valued without the impact of any market risk scenario.
 - no porting of accounts is assumed.
97. CCPs also provided the level of concentration add-ons in their margin framework (i.e. the additional margin called and received from each clearing member specifically to cover concentrated positions).

3.5.4 Position type coverage

98. The framework design ensures that most concentrated spread positions, even market neutral ones, are captured.
99. As the transaction costs add up, spread positions between two correlated but different underlyings are not offsetting. For example, a large short position in one equity and a large long position in another equity do not offset each other's costs. Likewise, electricity or commodity derivatives with different delivery points will be captured.
100. Curve / calendar spreads on the same underlying are captured unless all components fall in the same maturity bucket. Hedges with economic rationale such as delta hedging single stock derivatives with the underlying stock are considered.

3.5.5 Known limitations of the Concentration Risk Analysis

3.5.5.1 Limited scope

101. The exercise does not model the whole default management procedure. More specifically, there is no attempt to factor in the impact of an auction which could lead to smaller or bigger concentration costs. This impact could be significant for credit and fixed income derivatives that are modelled through their hedging portfolios.

102. Although we covered most of the cleared asset classes, markets like cross-currency basis swaps, longer term foreign exchange derivatives or less liquid foreign exchange pairs were not in scope.
103. Therefore, concentration risks on these segments is not quantified and there may be an underestimation of the concentration risk for default funds that include such asset classes.
104. To reduce complexity, some calendar / curve risks within asset classes are not being considered when they are categorized within the same buckets. Likewise, for some asset classes, market practices could allow for more aggregation than considered in the framework.
105. The liquidation of collateral is not covered to avoid making the exercise overly complex. For instance, it would have been necessary to model the change in the order with which resources are used for each CCP and depending on which CM is in default.

3.5.5.2 Model and calibration risk

106. The model chosen may be insufficiently accurate and / or fail to consider properly specific features of some asset classes. However, its results explain well some of the CCPs' own concentration risk models.
107. As the market impact estimates are provided by the CCPs, there is a risk to have a biased estimation of the real risks in stressed markets. For the same asset class, estimates submitted by different CCPs varied significantly. This already suggests a very different sensitivity toward concentration risk of different CCPs, which impacts the overall exercise.
108. In some cases (freight or emissions), few CCPs contributed and the final parameters seem particularly low. Given the lack of data available, it was difficult to challenge the CCPs and get better estimates.
109. For the future exercises, it would be desirable to reduce the reliance on CCPs to estimate market impact, through academic papers, use of available data, input from other institutions.

3.5.5.3 Market depth

110. For securities, the primary source for ADVs is the systematic internaliser data¹⁷ computed and published by ESMA.
111. In most other cases, the market depth was computed using the CCP's own submitted reference volumes, as they reflect the markets the CCP can readily access and for which it has in place the operational arrangements to readily execute transactions.
112. The submitted reference and aggregated position volumes could be affected by errors in the data provided or assumptions used by CCPs.
113. Sometimes, positions appear very large compared to the typical market volume. It would be better to remove this uncertainty from the model.
114. The two levels of validations (by NCAs and ESMA staff) aimed at limiting the risk of wrong computations by CCPs, but this risk cannot be completely eliminated with ex-post desk-based verifications.

¹⁷ The "systematic internaliser calculations" data files can be downloaded from ESMA Website: <https://www.esma.europa.eu/data-systematic-internaliser-calculations>.

3.5.5.4 Methodology for Credit Derivatives

115. The chosen methodology for credit derivatives may have been too lenient. For each sub-category / underlying, the positions were reported as a single 5Y equivalent.

116. The illiquidity of other maturities was not captured by the methodology.

3.5.5.5 Default waterfall

117. The analysis assumes no porting of accounts. The aggregate calculation of concentrated positions and potential costs per Clearing Member does not distinguish between the internal positions of different client / house accounts.

118. Indeed, the market would need to absorb the overall amount of the position regardless of whether the position is from a client or a house account. This does not mean that the framework assumes a mingling of positions and PNL or resources between House and Client but it models what the market reaction may be. This limits the ability to allocate losses to each account and makes the estimated liquidation cost not directly additive to the credit stress test losses:

- If the house and the client have each a position of e.g. 2 times the tradable volume, then the market impact is the impact of a position of 4 times the tradable volume. So, the market impact PNL of each account cannot be computed in isolation.
- The losses due to the client's positions are first offset against client margins; therefore, in order to compute how much of the losses due to concentrated positions affect the default fund, it would be necessary to have access to all client and house positions and resources and apply the waterfall. However, the EU-wide CCP stress test relies on the CCPs' own calculation for the market scenario PNL, while the concentration PNL is run by ESMA staff. To recompute the exercise in full, ESMA staff would have needed a full transparency on the structure of accounts.

119. The limitation implies that, in any clearing member default scenario, a concentration PNL is computed and compared to the magnitude of the losses at the CCP. This provides a breakthrough in terms of understanding how concentrated positions may represent a risk to financial stability.

120. But it does not allow to quantify the losses over margins in the same way as what is done for the impact of a market shock for the Credit component. It is therefore not possible to combine directly credit and concentration components. This would also have compromised the anonymity of the concentration component results. Nevertheless, in section **Error! Reference source not found.** we provided a simplified estimate of the combined credit/concentration component, and calculated minimum values of this combined impact using lenient assumptions on the allocation of losses.

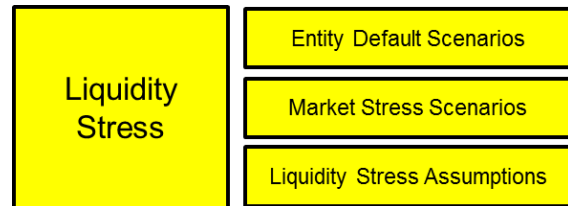
3.6 Methodology – Liquidity Stress Test

3.6.1 Overview of the liquidity modelling

3.6.1.1 Methodological principles for the liquidity stress test

121. For the purpose of the ESMA Union-wide Stress Test, liquidity risk can be defined as the risk that the CCP has insufficient liquid funds to meet its payment obligations in a timely manner when they become due over the relevant time horizon. It can arise due to unexpected generation of liquidity needs or (and) absence of sufficient liquidity resources.

122. The first stage involves the combination of market shocks with the simultaneous default of market participants. The scenario design shall reflect EMIR requirements with severe but plausible shocks. The shocks will be the ones applied in the context of counterparty credit risk. The default of market participants is the actual or technical insolvency of Clearing Members and/or providers of liquidity and services with impact on the liquidity profile of an individual CCP.



123. The second stage is a liquidity mismatch analysis of individual CCPs under the different scenarios; all projected cash in- and outflows, linked to clearing, facilitating settlements and payments and investment activities but also other cash flows stemming from relevant operational activities of the CCPs for the predefined time horizon are aggregated per time bucket and the counterbalancing capacity assessed.

124. A final assessment is made by testing additional assumptions and measuring the relative contribution of the different tools at CCPs' disposal to fill the liquidity mismatch.

125. For the purpose of this exercise, it is assumed that liquidity risk is generated by the following channels:

- **Variation Margin due by the defaulted CMs:** CCPs need to post cash VM to non-defaulting CMs for positions held by defaulted CMs.
- **Settlement of obligations of defaulted CMs:** cash flows are linked to fulfilment of the settlement of physical obligations of the defaulted CM. Cash outflows are generated when a CCP has to step in on behalf of the defaulted CMs to post cash to non-defaulting CMs or when a CCP needs to execute buy-in transactions for failed deliveries on behalf of the defaulting member.
- **Non-performance of liquidity provider:** which would imply a reduction of the counterbalancing capacity (e.g. investment counterparties, credit line provider, investment agent for funds received temporarily into its accounts, repo counterparties).
- **Non-performance of service provider** (e.g. the CCP cannot get access to the funds accumulated on its accounts with the payment / settlement / concentration bank due to its failure).
- **Failure of custodian** which would incur in delayed/impaired access to assets held with that custodian (including non-cash collateral and investments). We will assume no access at all for the liquidity horizon.

3.6.1.2 Timing aspects of the exercise

126. As is the case for Concentration, the liquidity stress test has been run on a single date (8 March 2019). It is assumed that all defaults occur simultaneously. Margins are collected as required on Day 0. Payment of margins by the defaulting members fails on the morning of Day 1, i.e. Monday 11 March 2019. The shocks are applied to the prices used for the last VM payment.

127. Market shocks are assumed to be instantaneous, and the market factors are then assumed to remain unchanged for the duration of the liquidity horizon (i.e. the final price will be the same if a position is closed on T+1 or T+n). This assumption has been made in order to facilitate the consistency and comparability of results across CCPs.

128. For the purpose of the liquidity stress test, CCPs were required to provide stressed cash inflows and outflows over the whole duration of the liquidity horizon. This liquidity horizon has been set at 7 days, as some CCPs use up to a 7 days MPOR on OTC products.

3.6.1.3 Liquidity assumptions

129. Based on the framework, various liquidity assumptions are made, covering both the market conditions and the tools available to the CCPs. In the computation of the results, we varied some of the assumptions to assess their impact. These assumptions are:

- Removal of excess collateral: this models the conservative view that in times of stress the members might reduce as much as possible their liquidity exposure to the CCP in order to maximise their own liquidity balance;
- market access delay of one day for any asset sale performed by the CCP when monetising collateral (including the use of non-defaulting members' collateral for liquidity purposes to the extent allowed);
- a settlement lag of 2 days for asset selloffs;
- no access to short-term FX markets (this assumption is relaxed when computing an overall liquidity position in addition to the analysis of the position per currency).

3.6.1.4 Member Default Scenarios

130. The model assumes the default of two entities to which the CCP is exposed. These entities may or may not be clearing members, and in all cases, when an entity is in default, it is assumed to default on all its functions vis-à-vis the CCP, i.e. if a clearing member is also providing liquidity facilities to the CCP, the default of the member is also affecting its performance as a liquidity provider.

131. ESMA developed 2 liquidity scenarios:

- Cover 2 group per CCP;
- Cover 2 group EU-Wide (which was labelled the “LDB” scenario in the previous Stress Test exercise).

132. The entities considered to be in default under the different scenarios are selected from an initial list of all entities having one of the following capacities: clearing members, issuers, custodians, payments banks or repo counterparties.

133. CSDs, Central Banks or issuers of government fixed income securities are never defaulted in the exercise. Similarly, the default of an interoperable CCP has not been considered.

134. The objective is to select in both scenarios the top 2 groups that would maximise the liquidity exposure of the CCP(s) as discussed in the next section.

135. The pair of groups that causes the largest liquidity exposure¹⁸ depends on the assumptions made. Therefore, a key choice had to be made on how to run the selection of these groups.

136. In theory, one could have run the selection for each set of assumptions. This would have been the

¹⁸ Naturally, the credit stress test selects two clearing members only and on the basis of credit exposures, while for liquidity we need to look at liquidity providers and liquidity exposures. Therefore, comparison of the selection of defaulting entities between credit and liquidity is not possible

most conservative option. However, having potentially different defaulting entities between (for example) the case with and the case without market access delay, would have made the results difficult to interpret.

137. Therefore, in order to ensure comparability of results and reduce computational requirements, it was decided to run the selection only once, by maximising the exposure when all liquidity assumptions are applied. This choice ensures that the worst liquidity position is achieved when all assumptions are "switched on" (i.e. 1-day market access delay² 2 days settlement lag, no access to FX market¹⁹).
138. The selection is based on the worst liquidity position aggregated over all currencies given the defaulting entities. In order not to select an entity based on a marginal gap in a marginal currency, any excess from one default fund is not restricted to that default fund. Therefore, the entities selected are not necessarily the worst ones in terms of liquidity for each currency.

3.6.2 Evaluating the liquidity position of a CCP

139. In line with the framework, ESMA staff assessed the liquidity position of each CCP in each of the currencies that it clears in, assuming that there is no access to the short-term FX markets. We will only report the results for the main currencies: EUR, USD and GBP.
140. In addition, an overall "EUR Equivalent" liquidity position of that CCP is assessed by relaxing the assumption of FX market closure at the CCP level.
141. Given a set of liquidity assumptions, the algorithm identifies: the liquid resources, liquidity requirements and other counterbalancing capacities.
142. The algorithm then computes the liquidity position, performing the aggregation according to the right of use of collateral rules²⁰.
143. The implementation of the methodology to compute exposures and resources was implemented through an in-house program. Therefore, there is no discretion in how the method is applied across CCPs.
144. The methodology was run on data provided by the CCPs and validated by the NCAs. As explained above, ESMA staff performed different levels of checks, ensuring for example a minimum level of consistency between credit and liquidity. However, given the nature of the exercise and its sensitivity to some of its inputs, the results could be affected by errors in the data provided or assumptions used by CCPs to extract these data. The two levels of validations (by NCAs and ESMA staff) aimed at limiting the risk of wrong computations by CCPs, but this risk cannot be completely eliminated with ex-post desk-based verifications.

3.6.2.1 Identifying the liquid resources – collateral and tools

145. Within the chosen default fund and the chosen currency, we selected all the liquid resources (defined in Article 47(1) of EMIR and Annex II of the RTS) that were not:
- in the custody of or issued by the defaulting entities;

¹⁹ Indeed, by "switching on" all the assumptions we worsen the liquidity position, as assets take more time to be liquidated and are not immediately available for liquidity purposes, and no FX market is available to generate liquidity in foreign currencies.

²⁰ For example: a security posted as collateral by a member may or may not be usable by the CCP for liquidity purposes for the management of a default

- a specifically excluded asset type
- uncommitted credit line²¹

146. For reverse repos with defaulting counterparties it was assumed that the CCP kept the collateral leg.

147. Liquid resources must be of one of the following types: Cash - Central Bank, Cash - Commercial Bank Secured (Reverse Repo), Cash - Commercial Bank Unsecured (Deposit), Government Fixed Income Securities, Other Fixed Income Securities, Equities or Committed Lines.

148. The liquid resources considered are the ones allocated to CCP own funds, committed lines, default fund contributions, required collateral / IM or SIG (skin in the game).

149. ESMA also modelled the fact that additional resources may come from the defaulting members whenever their losses did not exhaust the resources. This could include resources not used in one default fund, but that might be used in another one.

150. Once identified the liquid resources, the exercise tests different assumptions on how the CCP can access the tools used to fulfil its liquidity needs.

3.6.2.2 Identifying liquidity transformation tools

151. In order to transform non-cash collateral, the exercise allowed the usage of committed repo lines with commercial banks and central bank facilities for CCPs that have reported some.

152. It should be noted that two types of central bank facilities have been reported by CCPs²², namely:

- a routine access to overnight central bank credit;
- the extension of intraday central bank credit into overnight, under a penalty regime.

3.6.2.3 Identifying the liquidity requirements

153. In each relevant currency, the CCPs have reported the schedule of stressed flows arising from Variation Margin, Premium Settlements, Settlement. ESMA staff checked the reporting convention for flows to achieve consistency between credit and liquidity.

154. The algorithm selects the relevant liquidity requirements given the defaulting entities and the assumptions, assuming that the CCP will have to make / receive payments to / from non-defaulting clearing members.

155. Moreover, any net positive inflow stemming from a non-defaulting member but going through a defaulting payment bank will be considered lost if it occurs on Monday. This is done for each clearing member in each relevant currency.

156. The close of business schedule will add cumulative relevant cash flows per clearing member. Any flows from liquidity provisions are added at this stage.

²¹ While the current exercise does not aim at assessing individual compliance of CCPs with EMIR requirements, it is recalled that uncommitted credit lines are not allowed as liquidity resources under EMIR, hence excluded from this exercise.

²² As mentioned earlier, this report does not assess EMIR compliance. Therefore, in particular in relation to the two types of central bank credit, the report does not provide any indication as to whether those liquidity facilities are compliant with EMIR. The establishment of the framework of those facilities, therefore, also in addition to their interpretation, falls within the remit of the relevant central bank of issue.

3.6.2.4 Calculating Liquidity exposure profile

157. The schedule of liquid resources is modified to reflect the liquidity assumptions made on the removal of excess margin, the 1-daymarket access delay and 2-days settlement lag.
158. It takes into account the list of repo counterparties and their respective capacities per currency as well as central bank facilities. It is assumed that repos are entered up to the maximum capacity per currency given the available collateral for the maximum duration.
159. Likewise, the schedule of liquidity requirements is modified to reflect liquidity provisions. Under the chosen working assumptions, the schedule of liquidity exposures is generated by aggregating the different resources and requirements.
160. Having looked at the resources available in each default fund, ESMA then look at the resources available from the defaulting members that were not already taken into account. This could include resources not used in one default fund, and that could be used in another one.
161. The CCPs were able to define the largest usage possible for each resource (i.e. clearing member, default fund or CCP level). Some resources are restricted to clearing member or default fund level. This is a key aspect of the model since results significantly change from one CCP to another based on the allowed usage of resources.
162. For each non-defaulting clearing member that has the usage of its collateral restricted to itself, we take out from the liquidity position both its restricted liquid resources and the liquidity requirements for “IM change” and “Premium Settlements”. The “Variation Margin” and “Settlement” flows are unaffected as they are passed through.
163. We assume that all resources of defaulting CMs can be used at CCP level. We make the simplifying and lenient assumption here that even client margin of a defaulting member can be used for liquidity purposes only at CCP level.
164. We then perform the aggregation and get the final position per currency. The worst position over the schedule is taken as the liquidity position. This aggregation is performed in 2 different ways: with and without netting of liquidity excess / shortfall at Default Fund level, leaving ESMA with 2 indicators: total netted remaining resources (at both default fund and CCP levels) and excess / shortfall at CCP level.
165. Finally, to get the overall liquidity position, assuming access to the short-term FX markets, we aggregate all the currencies, converting them to EUR using stressed FX Rates.

3.6.3 Residual Limitations of Liquidity Stress Test

3.6.3.1 Link with the credit stress test

166. The credit stress test evaluated whether the CCP had enough collateral that it is entitled to use in the default waterfall in order to cover the losses caused by the default of two clearing members.
167. Since some of this collateral may take time to be available, the CCP can access other liquid resources to meet its requirements on time. This is taken into account in the liquidity stress test.
168. However, one important feature of this usage of liquidity is not modelled: when the default management is over, if the CCP has used liquidity resources that were not assets it may use to mitigate credit losses in the waterfall, it has to return them. For example, bonds of a non-defaulter that were sold to generate cash need to be returned to the non-defaulter.

169. It is therefore important to interpret the liquidity stress test as an exploration of additional issues, on top of those identified by the credit stress test.

3.6.3.2 Cross currency aspects

170. In the results, we perform the aggregation and get the final position per currency, as well as on an EUR-equivalent aggregated basis.

171. No modelling is made with respect to the access to the FX markets. Therefore, where a shortfall in one currency is showed, it shall only be interpreted as a need to trade a certain amount on the FX market.

172. Conversely, EU-equivalent results are based on the assumption that the FX market is functioning and that the transactions are instantaneous.

3.6.3.3 Concentration of collateral

173. The securities used by the members as collateral can sometimes be assets that are cleared by the same CCP or by another CCP.

174. The amount of securities used to generate liquidity is not assessed under the framework of concentration stress test.

175. The rationale is that in most cases the CCP has at its disposition more assets than the strict amount necessary (as the results section of this report shall further demonstrate). Therefore when it needs to sell or repo a bond to generate cash, the CCP's management can choose among the various assets available to it which ones to sell, to use for repo transactions, or not at all.

176. Unlike the securities that were part of the defaulter's portfolio and that the CCP has to sell, these assets do not have to reach the market at the same time, depending on choices made by the CCP.

177. It was not envisaged to model this behaviour and therefore the concentration framework is not applied to the liquidity stress test.

3.6.3.4 Other modelling simplifications

178. A number of additional simplifications were brought to the framework.

179. Intra-day liquidity and the number of settlement cycles per day was not modelled

180. Changes in initial margin requirements of non-defaulting CMs are not accounted for. Changes in IM may stem from:

- the expiry of trades and the change in positions. The CCP shall assume the trades occurring are the ones the CCP observed during the days following the selected default date (ignoring the new trades would imply all securities trades do settle and all margins are returned to non-defaulting CM, this would be both very penalizing and not realistic)
- the impact of the market shock on the historical dataset on which the margin model is calibrated. However, as detailed in the instruction, this effect was not modelled.

181. The tightening of the liquidity markets reflected by a reduction of committed lines and flight to quality in securities markets with eligibility implication on commercial repo markets is not modelled.

182. As for the credit stress test, potential second round effects on prices following the default of entities

are not modelled: the price shocks are the ones provided by the ESRB and there is no explicit link between the market prices and the number of defaults.

183. Actual liquidity needs may differ from the modelled liquidity needs based on the individual CCPs default management rule and procedures, including because of hedging transactions or optimisation of intraday cash use.

3.7 Methodology – Concentration of Resources

3.7.1 Concentration of Resources overview

184. The degree of concentration of CCP resources aims to identify the concentration of default fund contributions (credit risk analysis) or liquidity provided (liquidity risk analysis) at CCP and at the EU-wide level. The analysis focuses on individual legal entity level and at group level, for clearing members (credit risk) or liquidity providers (liquidity risk), respectively.
185. The degree of concentration of the CCP resources is calculated using the Herfindahl-Hirschman index (HHI), a measure developed and used in industrial economics to assess the extent of concentration/competition in a particular industry. HHI is defined as the sum of the squares of market share(s) of the N firms within an industry:

$$HHI = \sum_{i=1}^N s_i^2$$

186. The index ranges from 0 to 10,000 points. Increases (decreases) in the HHI indicate a decrease (increase) in competition. Competition and antitrust laws usually have the HHI as a reference concentration measure as the HHI has the property of assigning additional weight to firms with larger size (market shares are squared before being summed up).
187. In this analysis, the HHI methodology is applied to investigate the degree of concentration of available resources within a CCP and across CCPs as part of the stress test exercise (default fund contributions for credit and amount of liquid resources provided for liquidity).
188. The rationale is that higher concentration could entail higher risk, as default fund contributions/liquidity are provided by a reduced number of clearing members/liquidity providers. The more concentrated available resources are, the higher is the probability that stress in one institution will impact one or more CCPs, potentially having systemic consequences. As an example, if there were only one clearing member/liquidity provider allocating resources in a CCP, the concentration would be 100% and the HHI would equal 10,000. If there were thousands of clearing members/liquidity providers in a CCP, the allocated resources would have nearly 0% concentration and the HHI would be close to zero.
189. Concentration thresholds refer to the European Commission Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings (Section III)²³. The following levels are identified:

0– 1000	no significant concentration
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²³ Council Regulation (EC) No 139/2004 of 20 January 2004 on the control of concentrations between undertakings. Art 19 and art.20 of the EC Guidelines refer both to levels and changes in the HHI following a merger. In this analysis, we consider only levels as changes would not be applicable in the specific case.

1000 – 2000	low concentration
> 2000	significant concentration

190. Within the CCP framework, we define the HHI at CCP level and EU-wide level for both the credit and liquidity analysis. Details of the analyses and results for credit and liquidity risks are reported below.

3.7.2 Concentration of Credit Exposures

191. HHI is defined as the sum of squares of the share of default fund contributions by default fund within a CCP. The share is calculated as the sum of default fund contributions allocated by each clearing member for a particular default fund over the total held by a CCP for the same default fund.

192. The CCP level concentration is calculated following the HHI Weighed average Across DFs method (HHI WA). Weights are calculated from the default fund size ratio over the total for the CCP.

$HHIWA = \sum_{j=1}^M w_j HHI_j$ where w_j : default fund size ratio over the CCP total and $j... M$ are the different default funds of the CCP

For this analysis, the default fund contributions are used as a proxy for the credit counterparty risk assumed by the CCP towards its clearing members, as according to EMIR art.42 the contributions shall be proportional to the exposures of each clearing member.

3.7.3 Concentration of Liquidity Exposures

193. With respect to liquidity exposures, the HHI at CCP level is defined as the sum of squares of the share of liquid resources committed by liquidity providers within a CCP. The amount is expressed in EUR-equivalent; currencies have been converted using the ECB exchange rates when needed. The share is calculated as the sum of liquid resources allocated by each liquidity provider within a CCP.

194. For this stress test exercise there has been a methodological change in order to better capture the available liquid resources. Also, interoperable resources that are collected by CCPs from their members but then forwarded to other CCPs have been excluded²⁴. Interoperable resources are resources collected by the analysed CCP, but they are not directly available to that CCP as they are provided as collateral to the interoperable CCP. This exclusion is consistent with the “Analysis and Breakdown of Resources” section, where they were also excluded.

195. In addition to the interoperable CCP resources, we have kept the resource exclusions from the previous exercise. We have excluded resources provided as excess collateral and those resources that were reported as resources that can only be used to cover liquidity needs stemming from the default of the same clearing member.

²⁴ The resources that were reported as resources provided to other CCPs were excluded from this analysis. Where an allocation of the originally collected resources was needed, this was done excluding the resources that were provided by the fellow interoperable CCP.

4 Results

4.1 Analysis and Breakdown of Resources

4.1.1 Overview, Scope and Limitations

196. The CCPs included in the scope of the exercise reported detailed data on the required and available resources that is used to run the credit, liquidity and concentration stress tests. These are presented in the following sections. The analysis and breakdown of resources presented in this section is used to set the scene for the core stress test analyses, provide an overview of the size of the industry, the breakdown of activity by individual CCPs or participants and in this section we also look for convergent or divergent practices with regards to required and available financial resources.
197. Although one can identify different practices and risk management techniques, the purpose of presenting this data is not to benchmark individual CCPs. Different CCPs clear different products with distinct characteristics. The size of resources alone cannot indicate the effectiveness of the CCP's risk mitigation arrangements. The resilience of CCPs to adverse market developments is assessed using the core stress results.
198. The full set of data, covering all aspects of the analysis, was only available for one of the two reference dates of the credit stress test (8 March 2019), as this is the date for which all components of the stress test, including credit, liquidity and concentration, were run. The analysis is therefore limited, to the resources reported for this particular date. It should also be noted, that the resources available to CCPs may vary significantly from one day to another. The analysis cannot therefore provide any conclusion on the size of the resources held at any other time.
199. Finally, the presented data is not always directly comparable with similar data reported in the context of previous stress tests, because the underlying definitions have in many cases evolved to accommodate the extended scope and improvement in data quality. For example, the margin amount now reflects the collected margin collateral, including collateral collected to cover current exposures (as opposed to only forward exposures) and add-ons. Moreover, the margin that is forwarded to interoperable CCPs has not been considered in order to avoid double-reporting and reflect the fact that it is not immediately available for the CCP providing it. We have also not considered other Prefunded CCP Resources that can only be used after calling and using non-prefunded resources (Powers of Assessment).

4.1.2 Default Waterfall

200. Overall, the prefunded Resources collected by CCPs have increased if compared to the previous stress exercise. The total amount (and % share) of resources allocated to each tranche of the default waterfall across all CCPs can be seen in Figure 4.

201. The CCPs reported in total approximately 335 billion EUR of required margin, default fund contributions and other committed prefunded resources. The amount of mutualised resources alone contributed by clearing members to the Default Funds of all CCPs in March was 28.5 billion EUR. It is significantly increased compared to what was calculated in the previous stress test (+31% from 21.7 billion EUR). Moreover, the amount of dedicated own resources (skin-in-the-game) is also significantly higher (640 million EUR in March 2019 compared to 430 million EUR in the previous exercise). The required margin is also significantly higher (306 billion EUR compared to 249 billion EUR), but methodological changes do not allow a meaningful direct comparison. Although it would be interesting to identify the exact reasons behind this apparent increase of resources, the data collected for the purpose of this exercise did not allow such an investigation. Nevertheless, keeping in mind the limitations of this analysis, it can be assumed that the increase of cleared volumes, (which may be accentuated by the clearing obligation), has played a role in this direction.

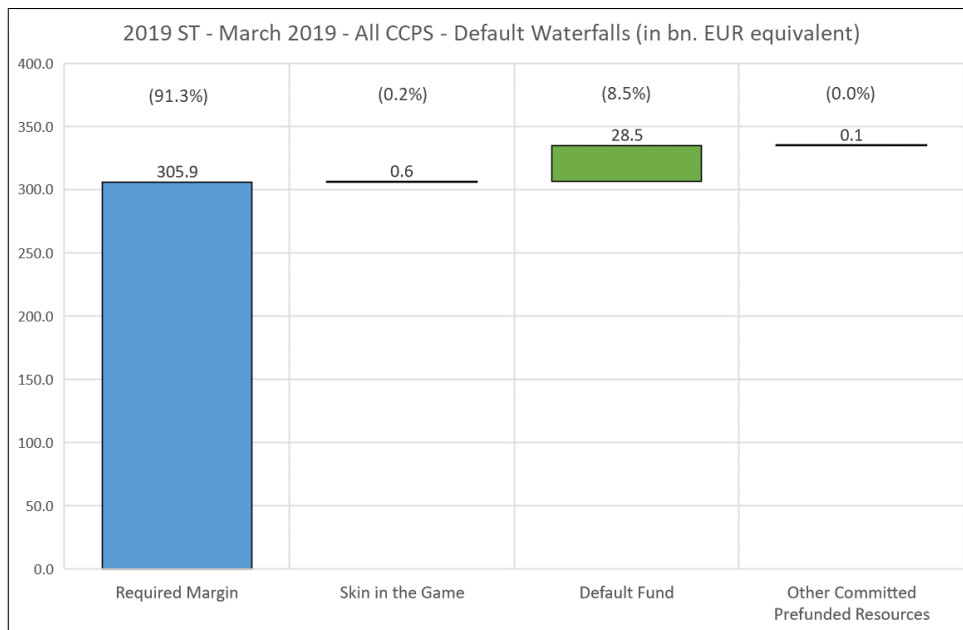


FIGURE 4: DEFAULT WATERFALL – ALL CCPs

202. We have also not identified any significant change in the relative allocation of prefunded resources between the different tranches of the default waterfall, i.e. margin, skin-in-the-game and mutualized resources. The required margin corresponds to 91.3% of the default waterfalls, while the default funds account for 8.5% and the CCPs' skin-in-the-game for only 0.2%. When comparing different tranches of the default waterfall, one needs to be very careful as the presented resources can only be used subject to the limitations provided in regulation and each individual CCP's rulebook. For example, the margin amounts allocated to clients' accounts can only be used to cover losses stemming from the same account, while margin cannot be used across clearing members. Therefore, not all amounts presented in the figure above will be available to cover losses. Of course, this is duly considered when losses are allocated in the core stress exercise.

203. The sizes of the two main tranches of the default waterfall (margin and default fund) are presented below for each CCP. In both charts, the CCPs are ranked by the total amount of required margin and, as in the previous exercise, it can be seen again that the top CCPs are significantly larger compared to the remaining CCPs. Especially the top CCP (LCHUK) accounts for approximately 47% of the total required margin and for 30% of the total default fund collateral.

Furthermore, it can be seen that the allocation of resources between margin and default fund contributions is not always proportional. For some CCPs the size of the default fund is significantly different compared to what would be expected using the margin as a predictor. For example, one CCP (CCG) is second in terms of default funds size and is only fifth in terms of margin requirements. This is also confirmed by the chart below (Figure 6) illustrating (in logarithmic scale) for each CCP the required margin versus the default fund size. This is further discussed when analysing the default waterfalls of individual CCPs.

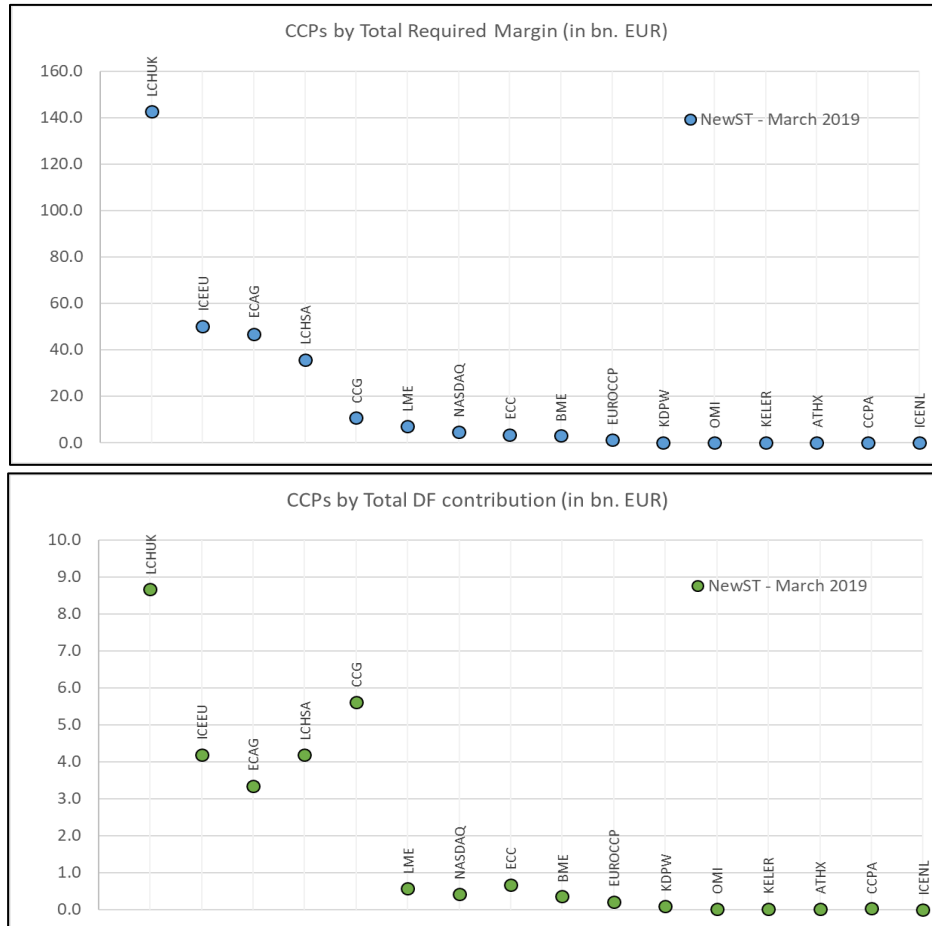
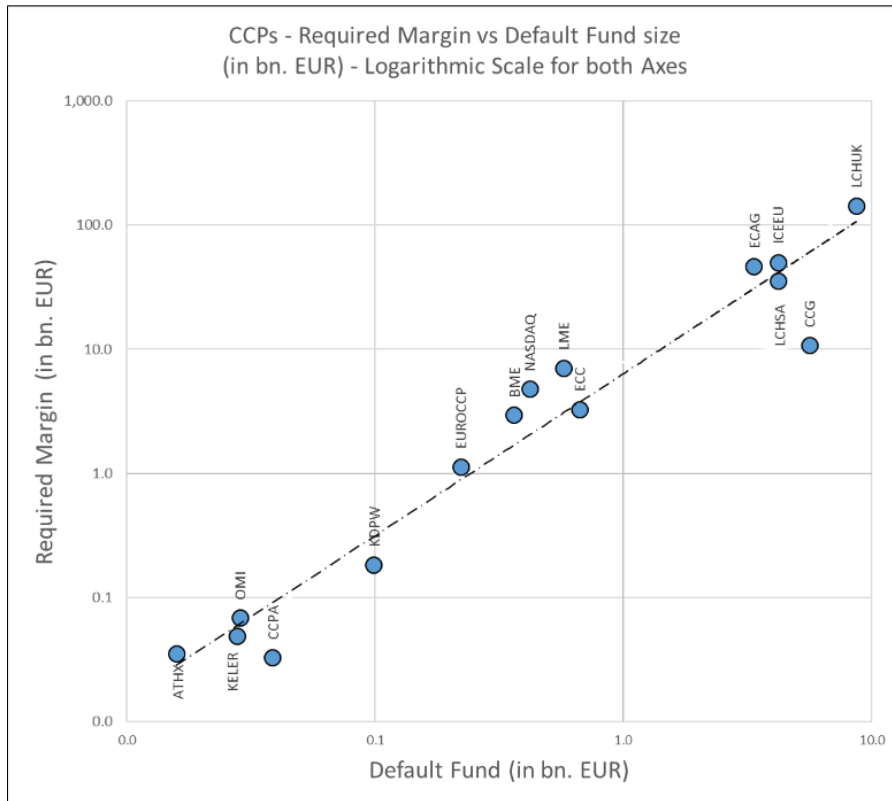


FIGURE 5: REQUIRED MARGIN AND DEFAULT FUND – PER CCP



204. Figure 6: Required Margin vs Default Fund – All CCPs
 Figure 7 If we zoom in on the default waterfalls of individual CCPs (Figure 7), it can be confirmed that, at least on an outcome basis, different CCPs have significantly different approaches with regards to the relative size of each tranche of their default waterfall. However, if compared to the previous exercise, there is no significant structural change. It seems that CCPs that were relying to a larger extent on mutualized resources (as opposed to margin), continue to do so.

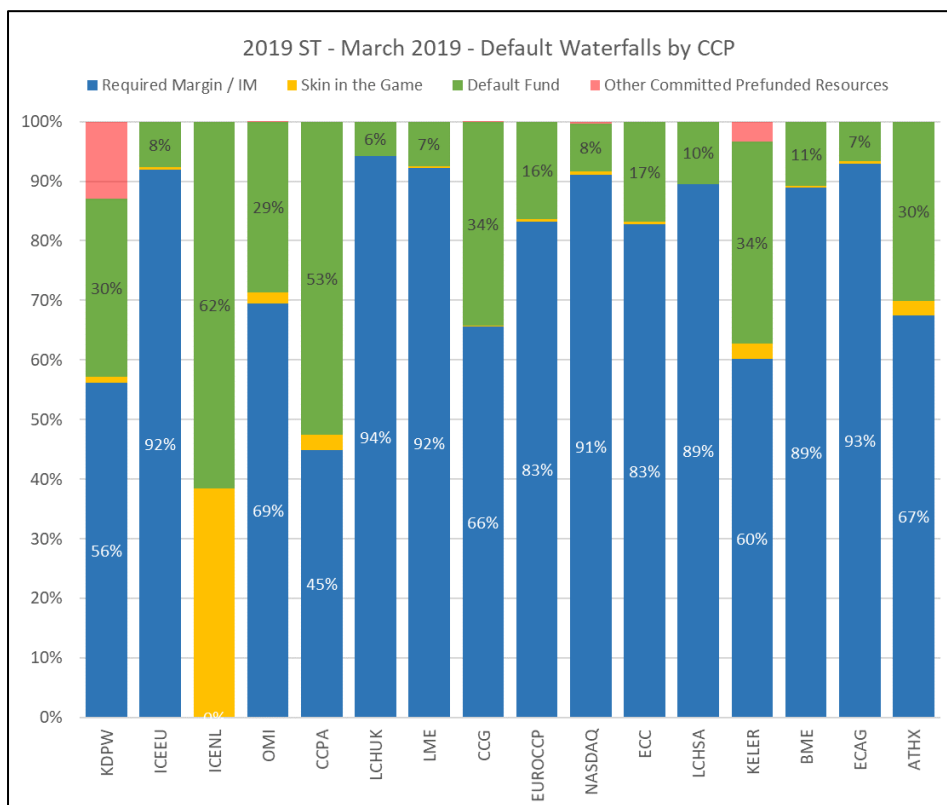


FIGURE 7: DEFAULT WATERFALL – PER CCP

205. One CCP (ICENL), reported zero margin requirements and zero (net) exposures. It was reported that all open positions were cleared by one clearing member in the same account and can actually be netted on both dates should the member default.
206. The skin-in-the-game is the prefunded amount that is dedicated by CCPs to be used before non-defaulting members' contributions. It can be seen that it is an "observable" part of the default waterfalls only for smaller CCPs. It looks very small if compared to the total waterfalls as it accounts for less than 3% with one exception. Although small, it could still be assessed as material in some cases if one would compare it to the Default Funds (1% - 8%, excluding the one outlier), as opposed to Margins, considering that both (default funds and skin-in-the-game) can be used to cover losses following the default of other entities.
207. With reference to the default fund, as a general rule, it seems that smaller CCPs tend to have a larger share of their coverage stemming from mutualized Resources. This could be explained by the fact that the top-2 participants represent a larger share of their activity. Also, on a theoretical basis and since all CCPs have to meet as a minimum and independently of their size the cover-2 requirement, the risk-sharing part will generally be smaller for CCPs that have a larger number of clearing members and smoother allocation of exposures across their top participants.
208. Moreover, it seems that CCPs that clear cash instruments (Securities) also rely more on mutualized resources. This could be explained by the fact that exposures can change significantly from one day to the other and mutualized Resources (Default Fund) are a more stable source of coverage, as opposed to margin that is asked ex-post.

209. In the context of the credit stress test, the assessment of the resilience of the CCPs will be primarily based on the minimum required margin collateral, as it can be assumed that a member in distress would not have posted excess collateral, while excess margin of non-defaulting members can anyway not be used to cover losses. The CCPs were asked to report separately the collateral that is provided in excess of the minimum requirement in order to give an indication of the actually available collateral on a particular date.

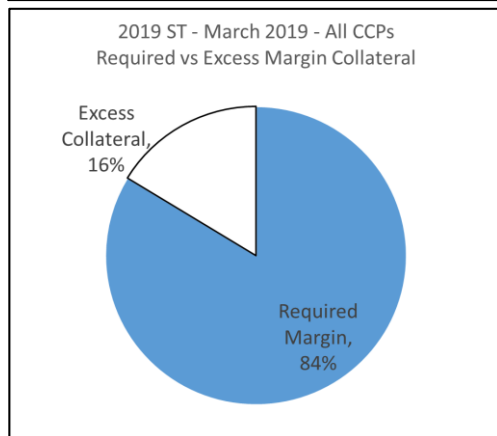
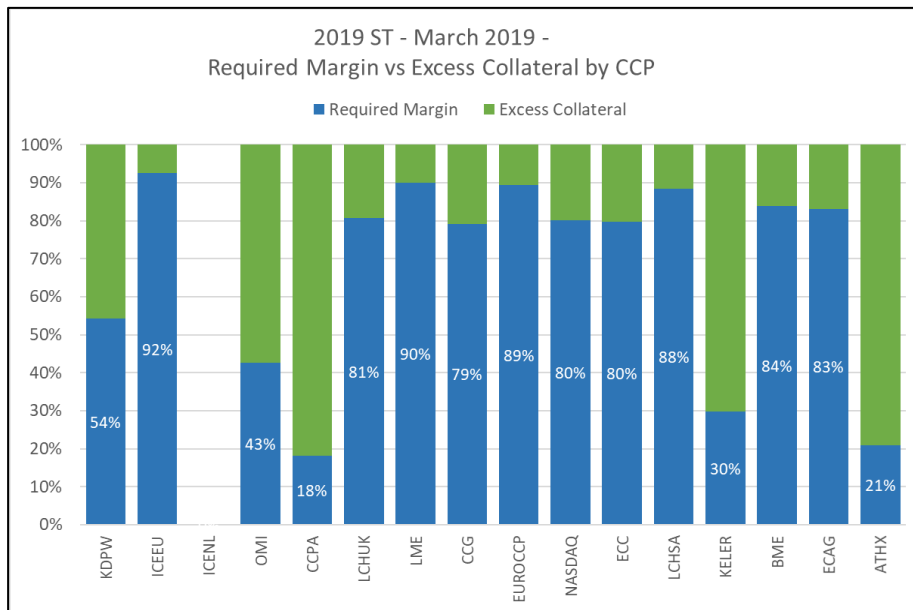


FIGURE 8: REQUIRED VS EXCESS MARGIN

210. Overall, the excess collateral accounted for approximately 60bn EUR and a relatively small percentage (16%) of the total provided margin collateral. If compared to the previous exercise, the total amount has increased, but in terms of share of excess compared to the required margin, no material change can be identified. Also, on a per CCP basis, the CCPs that were collecting a large amount of excess collateral continue to do so.

211. Although not always the case, it can again be noted that it is mostly the smaller CCPs and especially the ones that clear cash equities that have an exceptionally large share of excess collateral. This can be attributed to the fact that exposures can change significantly from one day to the other. Members prefer to over-collateralize their exposures, in order to avoid having to provide additional collateral on an intraday basis.

4.1.3 Clearing Members

212. When analysing the resources, it is interesting to change the point of view and try to understand if the increased resources provided to CCPs were contributed by only a few members, or if there was a general increase of provided resources by all clearing members. As discussed in the following paragraphs, the analysis shows that, indeed clearing members have in general provided more resources, but also the top participants have increased their relative share.
213. We have identified approximately 800 clearing members (single entities) being a member in at least one CCP. As expected, many entities are members in multiple CCPs. For example, we have 9 distinct entities that are at the same time members in 10 CCPs or more. The interconnectedness of CCPs through common clearing member groups is analysed and discussed in section 4.2.1.1. The number of clearing members and cumulative share (percentage), in terms of their aggregate contribution to the Default Fund of all CCPs and in terms of the aggregate margin required again from all CCPs (Figure 9) are presented below. In brackets one can see the corresponding number of entities as identified in the previous exercise and in light grey (dashed line) the relevant share of resources.
214. The top-5 clearing members have each a total margin requirement (across all CCPs) that is greater than 10 billion EUR, while no clearing members had such a high aggregate margin requirement in the previous exercise. This can be primarily attributed to the overall increase of CCP resources, but not only. Indeed, the general increase of resources has pushed the top participants to higher levels, but at the same time, the top participants have also increased their relative share. For example, the top-18 members contribute cumulatively 50% of the required margin across all CCPs compared to the 22 that were needed to achieve this share in the previous exercise. Also concerning default fund contributions, 17 clearing members have each contributed more than 500 million EUR across all CCPs, compared to 10 members in the previous exercise.

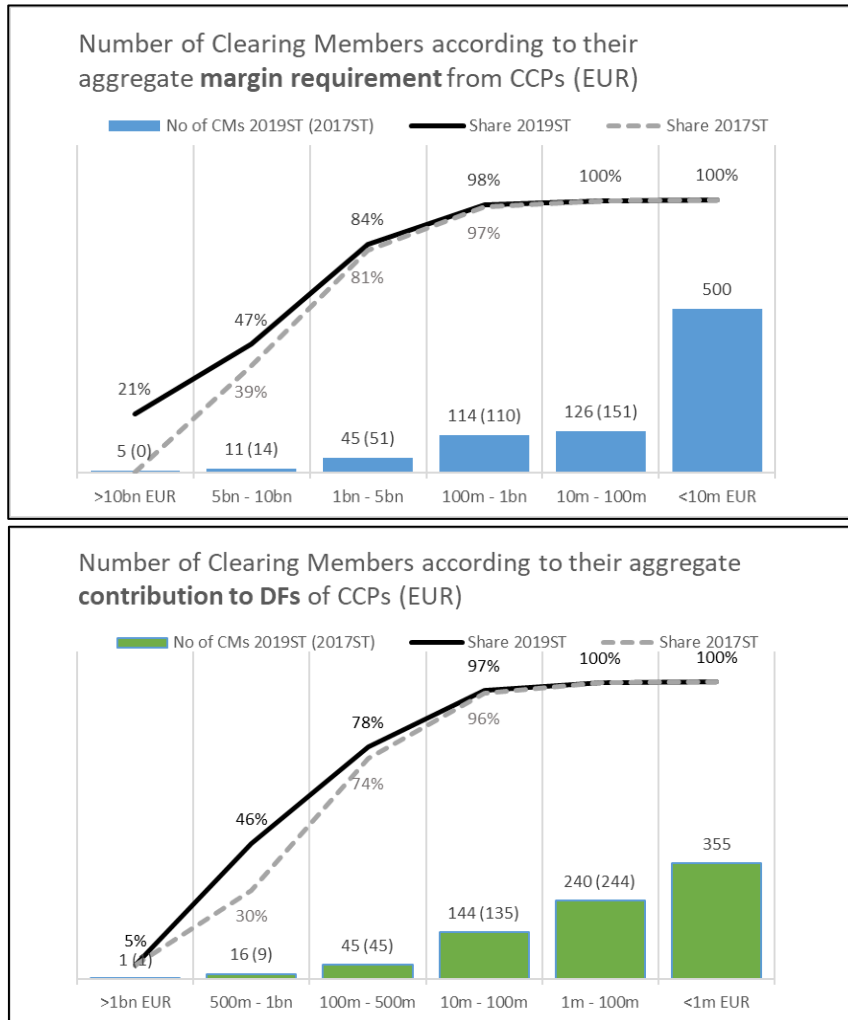
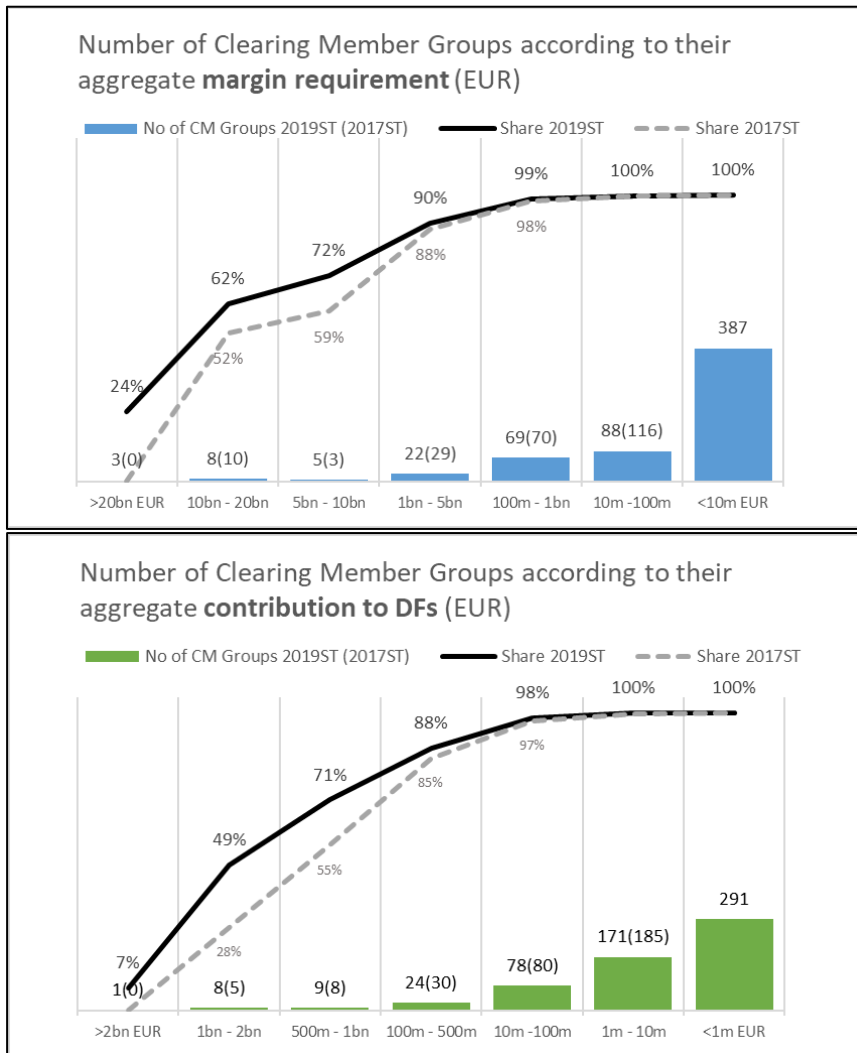


FIGURE 9: CLEARING MEMBERS – ALL CCPs

215. As expected, when the same analysis is run at the corporate group level, after adding the resources provided by affiliates within a single group, the level of concentration increases further (Figure 10). The top Clearing Member Groups have contributed more resources, both in absolute and in relative terms. In particular, the top-5 clearing member groups account for 37% of margin requirement, compared to 30% in the previous exercise.

216. Also in absolute terms, three (3) clearing member groups have each a total (across all CCPs) margin requirement that is higher than 20 billion EUR, again compared to none found in the same band in the previous exercise. Also concerning the default fund contributions, 9 clearing member groups have each contributed to CCPs' default funds more than 1 billion EUR (it was 5 in the previous exercise). Finally, the top clearing member group in terms of aggregate margin requirement and default fund contribution across all CCPs in scope of the exercise has provided close to 30 billion



EUR.

FIGURE 10: CLEARING MEMBER GROUPS – ALL CCPs

4.1.4 Powers of Assessment

217. According to EMIR, the CCPs shall maintain sufficient prefunded resources to cover potential losses that exceed the losses to be covered by margin requirements and the default fund. These shall enable the CCP to withstand the default of at least the two clearing members to which it has the largest exposures under extreme but plausible market conditions. The CCPs may, subject to their rules, require non-defaulting participants to provide additional non-prefunded resources that could be used to cover any residual losses that exceed the prefunded amounts (Powers of Assessment). We have asked the CCPs to report the maximum powers of assessment that can be called from

each clearing member and per each default fund in accordance with their own Rulebook.

218. The observed increase of default funds also entailed an increase of the level of additional non-prefunded resources that the CCPs have the right to call from non-defaulting members. The main reason is that the maximum amounts that can be called scale up together with the already contributed amounts. In fact, it is a standard practice for CCPs (that have reserved this right) to link the maximum amount to be called from a clearing member to the number of defaulting entities, also expressed as a multiplier of its default fund contribution at the time of a default.

219. The majority of CCPs have reserved the right to call for additional non-prefunded resources. In particular, 14 out of the 16 CCPs reported having this right. The powers of assessment are not to be confused with the additional funds that should be called by all CCPs to replenish a default fund after a default and in order to prepare for potential future defaults. The powers of assessments are generally meant to cover residual losses (over the prefunded resources) stemming from already experienced defaults.

220. Across all CCPs we have calculated the maximum amount that can be called, by a single CCP and in one Default Fund. In the Figure 11, one can see how the maximum amount that can be called, evolves for an increasing number of assumed defaults. The blue bars reflect the maximum amount from the previous exercise and the red bars the maximum amount as calculated in the current exercise.

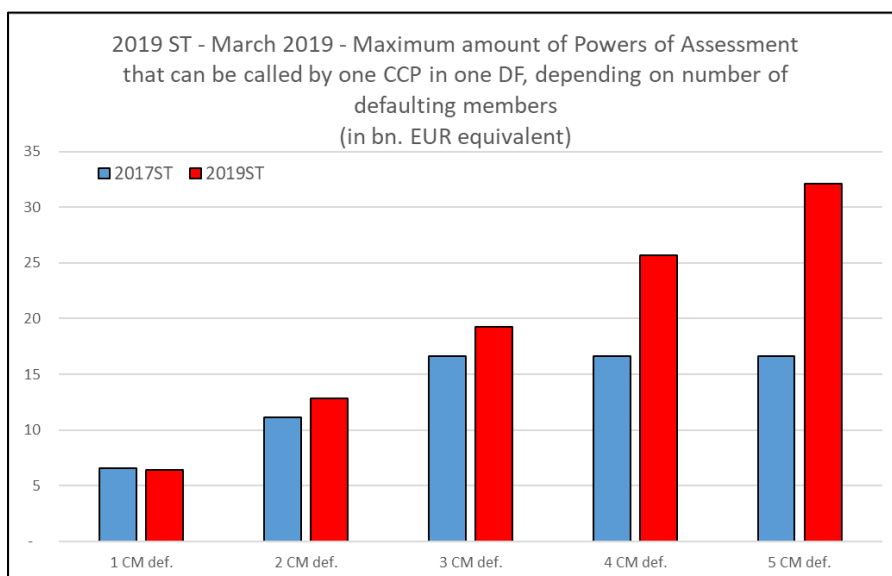


FIGURE 11: MAXIMUM AMOUNT OF POWERS OF ASSESSMENT THAT CAN BE CALLED BY A CCP

221. It can be observed that the maximum amount of non-prefunded resources that can be called has increased. It should be noted that the compared amounts for the two exercises can refer to different CCPs, but always refer to the maximum amount that can be called by one CCP. Assuming the default of 2 clearing members in one default fund, the maximum amount that can be called by a single CCP is approximately 12.8 billion EUR (compared to 11.1 billion EUR in the previous exercise). The increase is even more apparent when we assume a larger number of defaults. This is mainly a result of the increase of default funds, especially for CCPs that have the right to ask for more resources (i.e. have a higher multiplier), thus driving up the maximum amount of powers of assessment that can be called.

222. Moreover, to the contrary of what is observed now, the maximum amount in the previous exercise did not increase when assuming 3 defaults or more. This was the case because many CCPs have

set a cap of the amounts that can be called at a certain number of clearing members defaulting. This is meant to implement the EMIR requirement that the clearing members shall have limited exposures towards the CCP. However, as it was commented in the previous exercise and confirmed again now, this is not a common practice for all CCPs. It seems that this provision is in some cases interpreted as a requirement to have limited exposure per default of clearing member. Nevertheless, the actual impact on non-defaulting clearing members through the risk-sharing mechanism of CCPs, including the potential additional non-prefunded calls, is assessed in the knock-on analysis.

4.1.5 Collateral per Asset Type and Currency

223. The CCPs reported the margin collateral and default fund contributions, also broken down per currency and asset type. This data is analysed here to provide an overview of the allocation of resources in an effort to identify outliers, diverging practices or increased concentration in particular currencies or asset types.
224. In this exercise we asked the CCPs to report the collateral both as initially provided by the members and (where applicable) after any re-investment performed by the CCPs. This gave us more visibility with regards to the type of collateral that are provided by the clearing members and the investment practices of CCPs. In fact, the CCPs may re-invest the received collateral, subject to specific requirements, thus changing the original currency or asset type. Due to the re-investment of received collateral, there is not always a direct (one-to-one) link between specific available assets and the origin of the provided collateral (i.e. which member provided the resources, in what form and for what purpose). Therefore, where provided resources were reinvested, the CCPs were asked to allocate the available assets proportionally. It should again be noted, that the analysis presented in this section corresponds to a snapshot of the total resources that were available on one single day in the past and do not provide any information on the resources held at any other time including the time of publishing the report.
225. The aggregate breakdown of all CCPs' collateral in terms of different asset types is presented in the Figure below. It provides a snapshot of the margin²⁵ and default fund collateral as available at the CCPs on the reference date, after any reinvestment. Similar to what was observed in the previous exercise, overall 59% of the resources correspond to Bonds and Equities, 40% to cash and less than 1% are provided in other types of eligible collateral²⁶.
226. Concerning cash, we see that a significantly larger share of the cash is now kept at central banks. In fact, 50% of the cash (it was 42% in the previous exercise) is kept at a central bank and 49% (was 57% in the previous exercise) under arrangements that secure its collateralisation, leaving again only 1% kept in the form of deposits (unsecured) at commercial banks.
227. The vast majority (94%) of Bonds & Equities are again Government Fixed Income Securities, while 6% are Other Fixed Income Securities and less than 1% Equities. We see a small decrease in a very limited overall share of Equities. A small decrease in the overall share of Other Fixed Income Securities is most probably attributed to a more consistent acknowledgment of the types of issuers from different CCPs²⁷. For the purpose of this exercise, CCPs were instructed to classify fixed

²⁵ With regards to margin, this analysis includes required and excess collateral. The analysis is based on the EUR equivalent value of resources after applying the FX shocks.

²⁶ Other types of eligible collateral that were reported for one of the reference dates include bank guarantees, gold, metal warrants and electricity certificates. The collateral that is collected by CCPs and subsequently forwarded to other (interoperable) CCPs is not included in this analysis.

²⁷ Where inconsistencies were identified in how the same issuers of securities were reported by different CCPs, we asked the CCPs/NCAs to confirm their status and updated for all CCPs to ensure consistency of the report.

income securities as Government Fixed Income Securities when they are issued or explicitly guaranteed by a government, a central bank, a multilateral development bank, the European Financial Stability Facility or the European Stability Mechanism. They are classified as Other Fixed Income Securities otherwise.

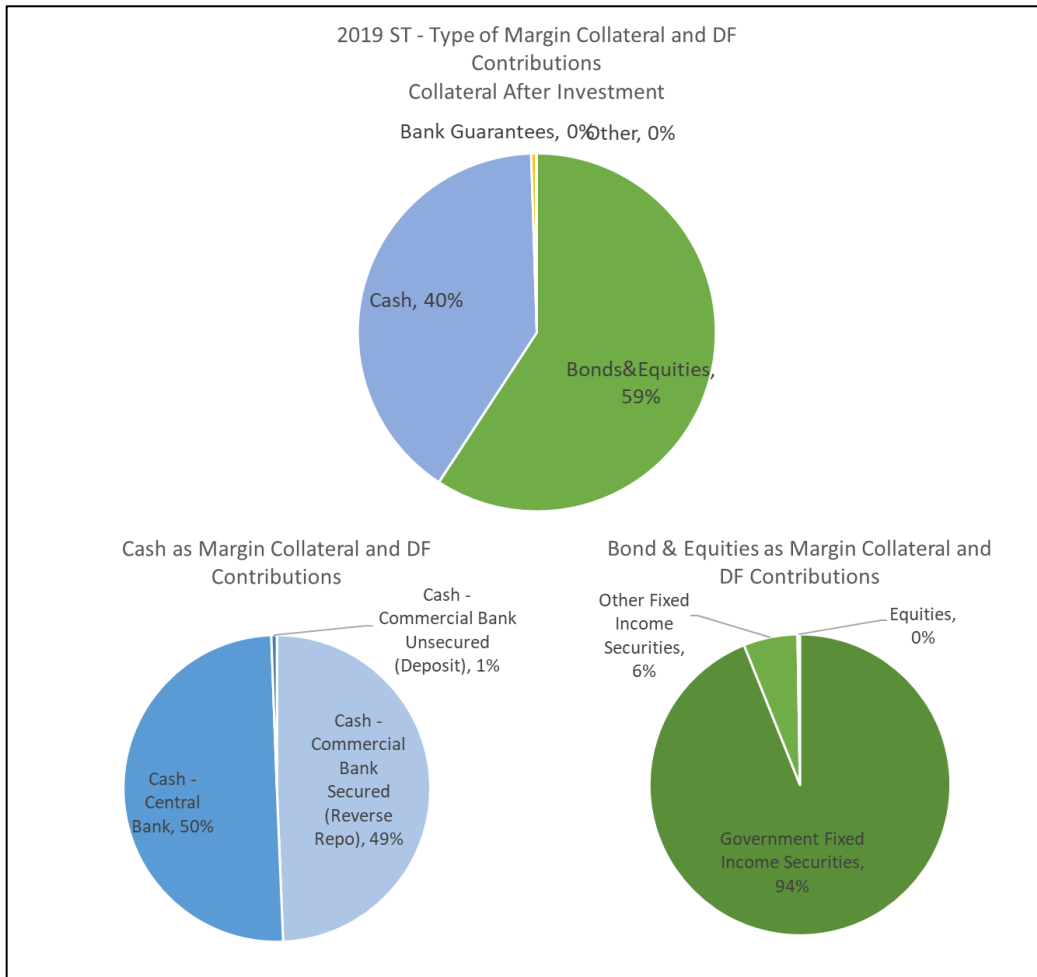


FIGURE 12: TYPE OF COLLATERAL – ALL CCPs

228. In terms of currencies (Figure 13), approximately half of the margin collateral and default fund contributions are available in cash or assets denominated in EUR. We see a small decrease of the amounts kept in EUR (48%) compared to the 53% that was recorded in the previous exercise.

229. In terms of the three major currencies for the CCPs in scope, the share of USD has slightly increased from 25% to 28% and we saw no change for GBP (11%). On the other hand, the share of JPY grew rather significantly (from 4% to 7%) when at the same time the share of CHF decreased from 5% to 2%. Of course, as expected the CCPs that clear products in other currencies have collected collateral that are denominated in these currencies.

230. Finally, in this exercise we asked the CCPs to report collateral both as provided by members and after their reinvestment. Based on this analysis we have not observed any significant currency transformation as part of the “business as usual” investment practices of the CCPs, i.e. reinvestment of collateral to change currency.

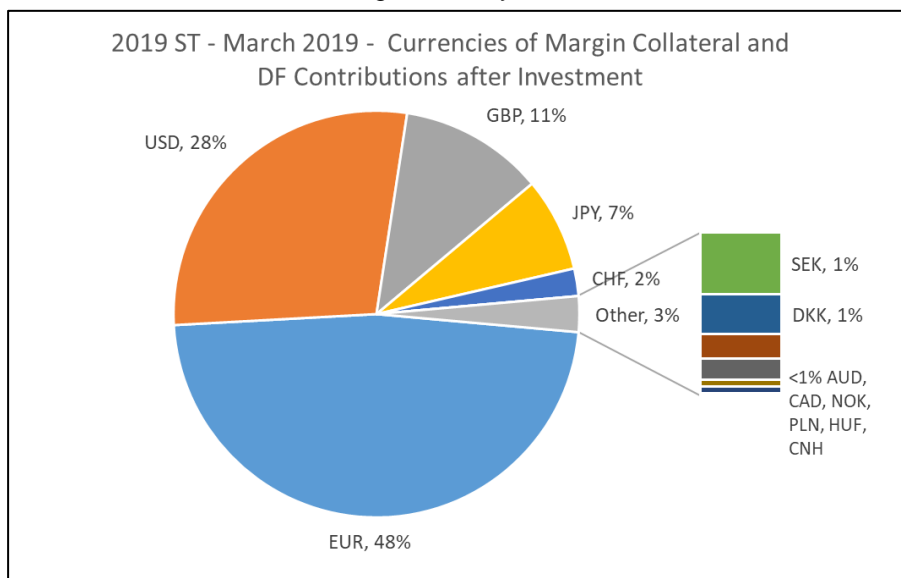


FIGURE 13: CURRENCY OF COLLATERAL – ALL CCPs

231. In order to analyse whether there could be any cases of divergent approaches or over-reliance on specific types of eligible collateral at particular CCPs, the breakdown of collateral as these were provided by clearing members is presented for each CCP in Figure 14.

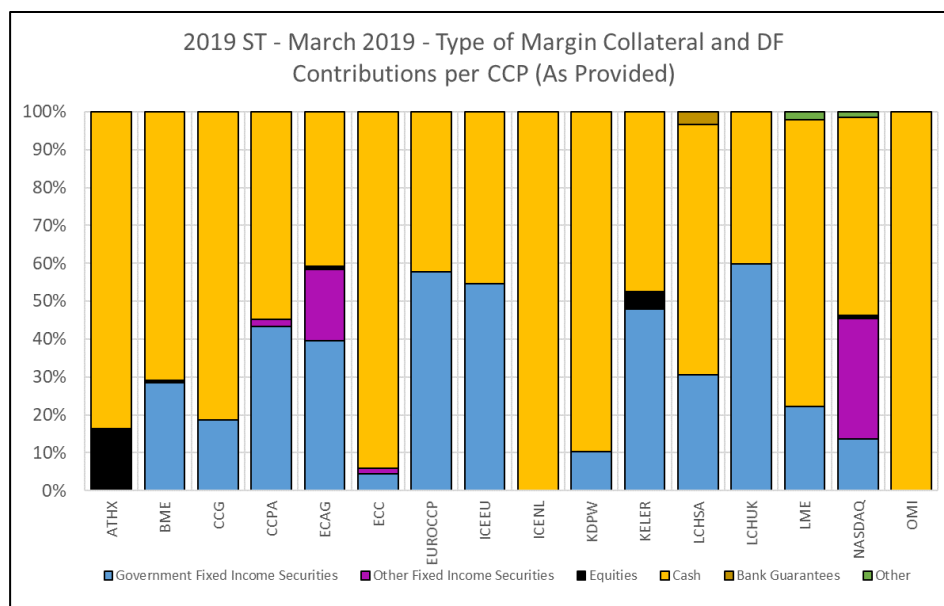


FIGURE 14: TYPE OF COLLATERAL AS PROVIDED – PER CCP

232. For all CCPs more than 40% of the collateral is provided in the form of cash, while for the majority of CCPs cash represents more than half of the collateral provided. Moreover, all but three smaller CCPs have collected Government Debt as collateral.

233. Five CCPs have reported Other (non-government) Fixed Income Securities, but for two of them,

they constitute a large share of the provided Collateral, i.e. 32% for NASDAQ and 19% for ECAG. Amongst others, these include covered bonds and bonds issued by financial institutions. These CCPs reported a large share of other fixed income securities also in the previous exercise.

234. With regards to equities, although the overall share across all CCPs has decreased, six (6) CCPs still reported receiving Equities, while for two CCPs (ATHX with 16% and KELER with 5%) it is a material share of the provided collateral. For both CCPs the share has increased compared to the previous exercise, but especially for ATHX it now represents a significant share of the provided collateral (16%).

235. No commercial Bank Guarantees were reported for March, but one CCP (KELER) reported commercial bank guarantees for December (not shown in the figure above as we report the collateral for the March date). Moreover, one CCP reported Guarantees provided by Central Banks.

236. Beyond Cash and Debt, two CCPs reported a relatively small share being provided in an “Other” type of collateral on at least one of the two reference dates, including Gold and Metal Warrants at one CCP (LME) and Electricity Certificates at another CCP (NASDAQ). As it can be seen in the figure above, in both cases, these represent a very small part of the provided collateral.

237. In the following figure (Figure 15) we have the breakdown of collateral post investment. With regards to cash that was received from clearing members, one can now see how this cash is kept or invested. As expected, we can see that some CCPs invest part of the cash received in Government Fixed Income Securities. As commented when discussing the overall, across all CCPs, picture the share of cash kept at central banks has increased significantly. We have three CCPs (EUROCCP, ICEEU and OMI) that reported no central bank cash in the previous exercise, having now reported such deposits.

238. Two CCPs reported keeping a very large share of the cash in unsecured deposits with commercial banks. In both cases, this accounts for approximately 70% of the cash and 35% of all collateral. For the one CCP (CCPA) this is cash kept in the name of the clearing member but pledged as collateral for the CCP. For the other CCP (KELER) this cash is kept at the CSD that belongs to a central bank. For two other CCPs (KDPW and OMI) the share of cash kept in unsecured deposits was just below 5% of the available cash.

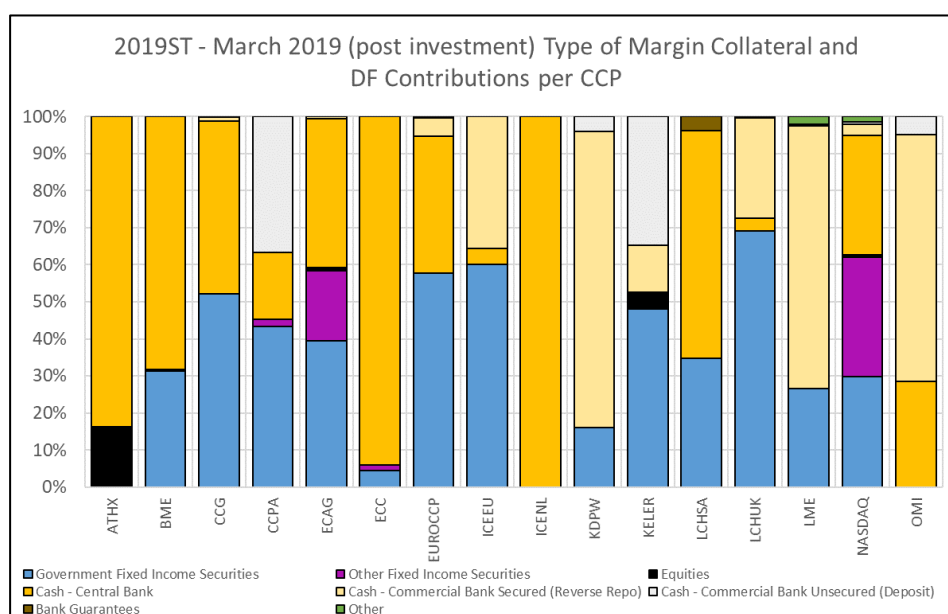


FIGURE 15: TYPE OF COLLATERAL AS INVESTED – PER CCP

4.2 Interconnectedness and Concentration of Resources

4.2.1 Interconnectedness

239. Interconnectedness can be defined as the network of direct and indirect exposures stemming from any type of trading links, as well as any contractual relationship that could give rise to a credit or liquidity dependency. Interconnectedness can serve as a significant channel of contagion by enabling the spreading of a financial shock between sets of entities or markets that were not directly connected. The failure of a large interconnected counterparty will typically have a wider impact than the failure of a similarly large but less interconnected one. This section investigates potential issues arising from interconnectedness of CCP networks through common clearing members, common custodians and common liquidity providers.

240. Even though some of the measures of exposures used in this exercise sometimes differ from the one used in previous exercises, hence making direct comparisons between results difficult, the below analysis enables us to identify trends in interconnectedness levels. Interconnectedness remains, as in the previous iterations, very high when looking at common clearing membership. This is especially true when looking at the stressed conditions (total losses over required resources) where interconnectedness has increased significantly since the last exercise, also reflecting more stringent stress conditions this time. Interconnectedness through common custodians remains at the same level as in the previous exercise, with some institutions concentrating the provision of this service. Finally, interconnectedness through liquidity providers remains at lower levels than for clearing members and custodians, but issues could arise, especially when considering non-committed liquidity resource providers and also bearing in mind that these liquidity providers are often clearing members at the same time.

4.2.1.1 Interconnectedness of CCPs through clearing member groups

241. First, we analyse interconnectedness arising from exposures to common clearing members. The exposure of a CCP to a clearing member group (Figure 16) is measured by the aggregated default fund contributions (DFC) and margins requested from clearing members at group level.

242. In all the figures and charts in the interconnectedness section, for readability purposes only the ten biggest groups, in terms of the described measure, are displayed in the middle in blue while CCPs are on the sides in red. The sizes are normalised, with the thickness of the lines proportional to the exposures between each clearing member and each CCPs (here, DF and Margins), while the size of a bubble is proportional to the sum of the aggregate exposure of the CCP or counterparty.

243. As observed in the previous ESMA stress test exercise, the EU central clearing environment appears to be very interconnected via common clearing membership with most CCPs connected to several of the ten biggest EU clearing member groups.

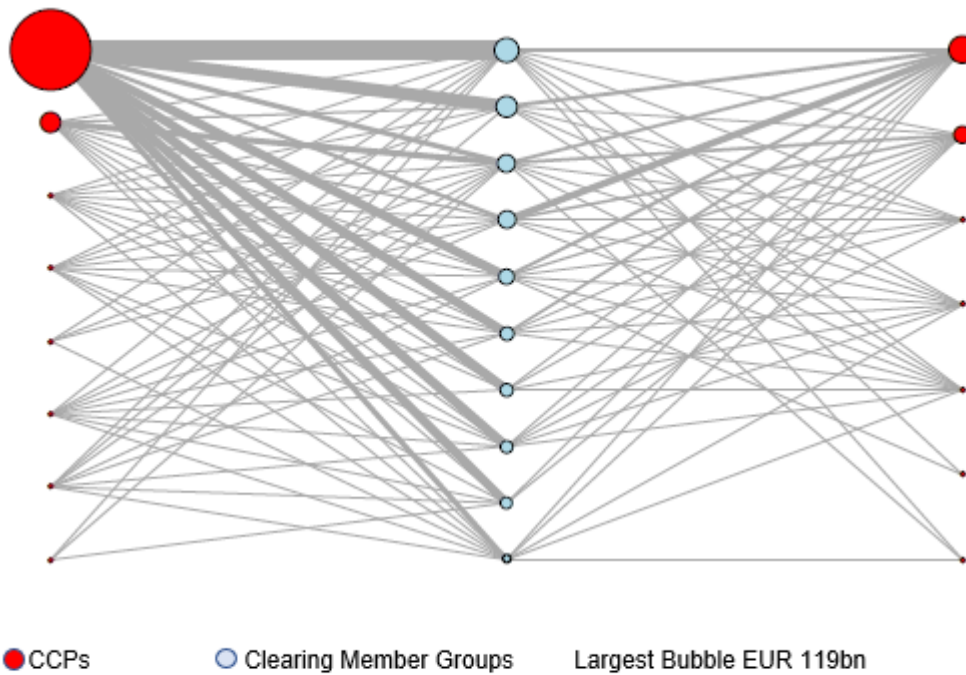
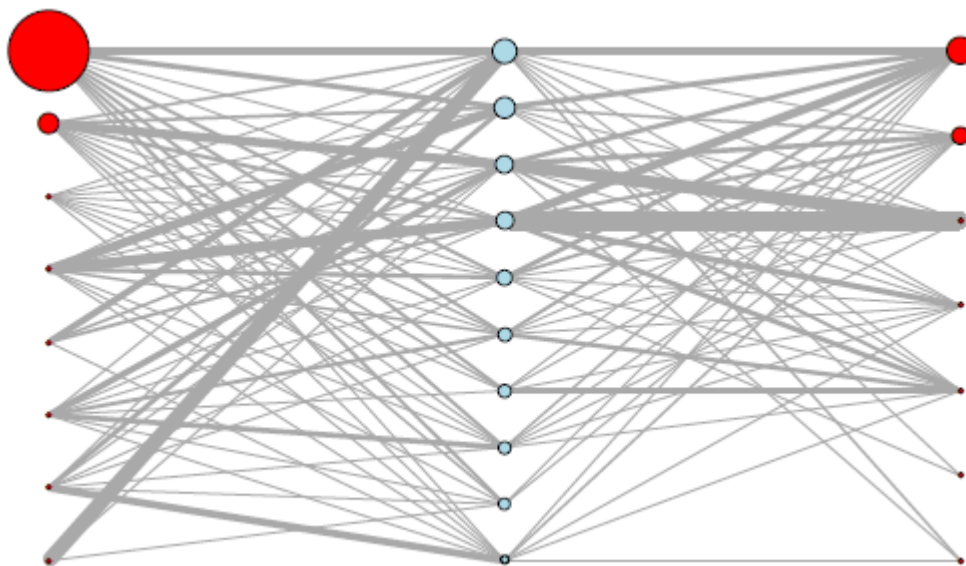


FIGURE 16: NETWORK OF TOP-10 CLEARING MEMBER GROUPS BY DF CONTRIBUTIONS AND MARGINS

244. While it is clear that CCPs are connected to common clearing members, the relative size of one CCP dominates the picture and could lead to an underestimation of the risk for the others. It is thus useful to display the exposures (thickness of the lines) in relative terms with respect to the size of the CCP. In Figure 17 below, the thickness of the line between a clearing member and a CCP is proportional to the exposure (DFC + Margin of the CM to this CCP) over the size of this CCP (sum of DFCs and Margin collected from all clearing members by this CCP). Some new patterns not visible in Figure 16 now emerge with the potential impact of interconnectedness on some smaller CCPs becoming more visible.



● CCPs ○ Clearing Member Groups Largest Bubble EUR 119bn

FIGURE 17: NETWORK OF TOP-10 CM GROUPS BY DF CONTRIBUTIONS AND MARGINS OVER CCP SIZE

245. Since interconnectedness can act as an amplifier of financial shocks, it is important to look at it in the context of market stress. Figure 18 shows the clearing members exposures as measured by stress loss over required resources (as calculated under the credit stress test scenario considered in this exercise). Even though the amounts (EUR 2bn for the largest bubble) are relatively small, this shows that interconnectedness could be present in the form of common clearing members being put under stress at the same time. At the same time, the results are higher compared to the previous CCP stress test exercise, partly resulting from the increased severity and scope of this year's stress scenario.

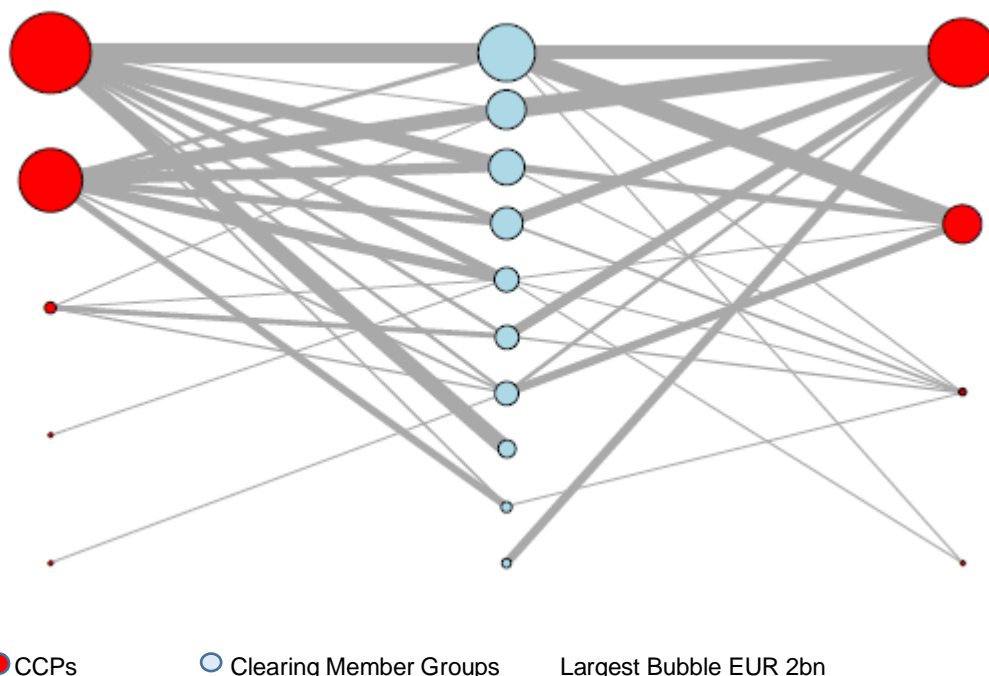


FIGURE 18: NETWORK OF TOP-10 CM GROUPS BY TOTAL LOSS OVER REQUIRED RESOURCES

246. Figure 19 below shows CCPs interconnectedness through their power of assessment, based on the unlikely assumption that CCPs would call the maximum powers of assessment that can be called from each clearing members at the same time. This gives an indication of potential interconnectedness from simultaneous calls once pre-funded resources are exhausted. Finally, an additional chart in the Annex (section 6.3.1) gives the interconnectedness through losses arising from the concentration component in section 4.5. This chart shows a similar level of interconnectedness than the other clearing member measures.

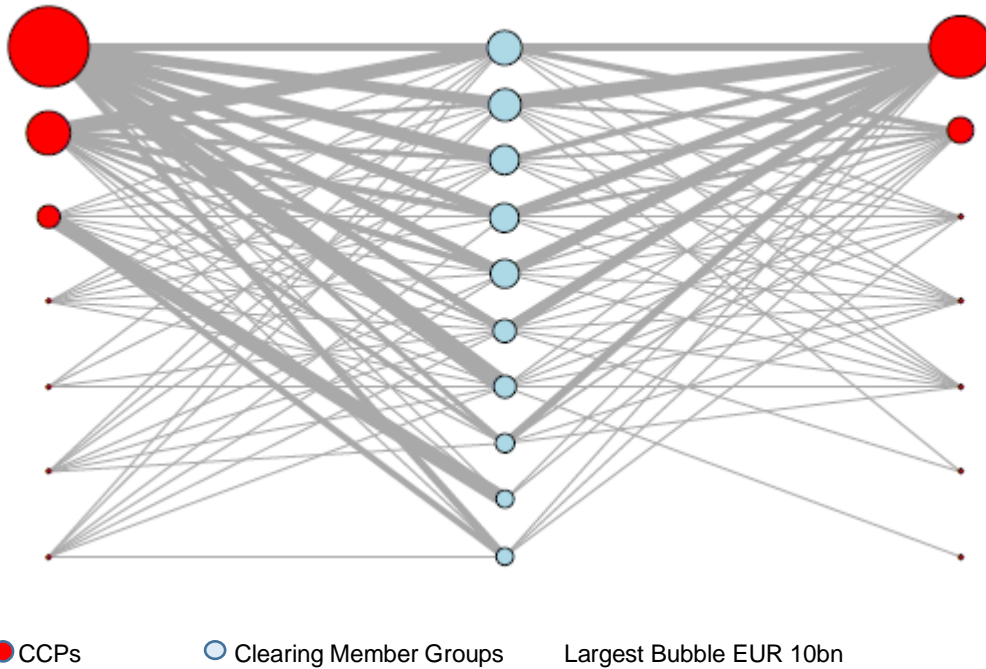
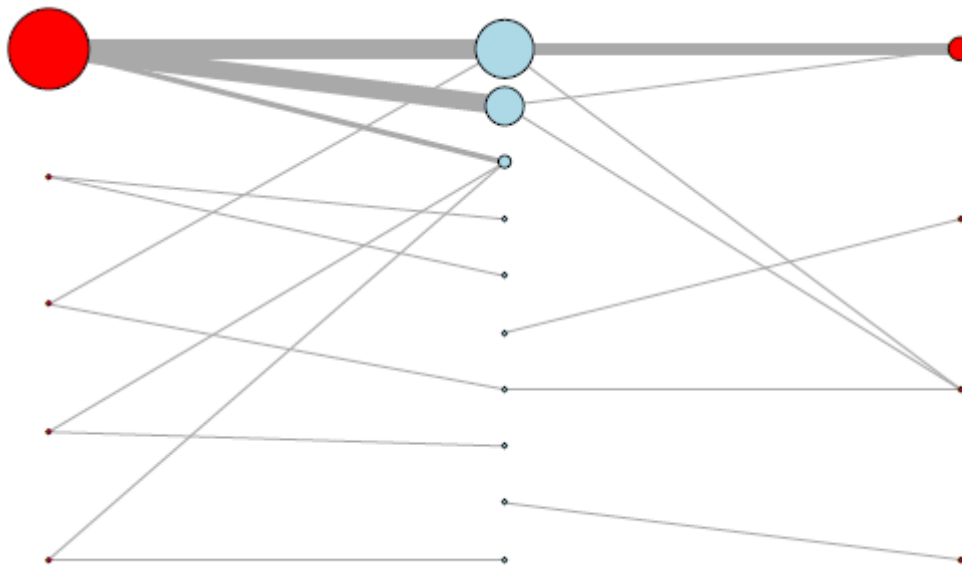


FIGURE 19: NETWORK OF TOP-10 CM GROUPS BY POWER OF ASSESSMENT AFTER DEFAULT OF 2 CM

4.2.1.2 Interconnectedness of CCPs through custodians

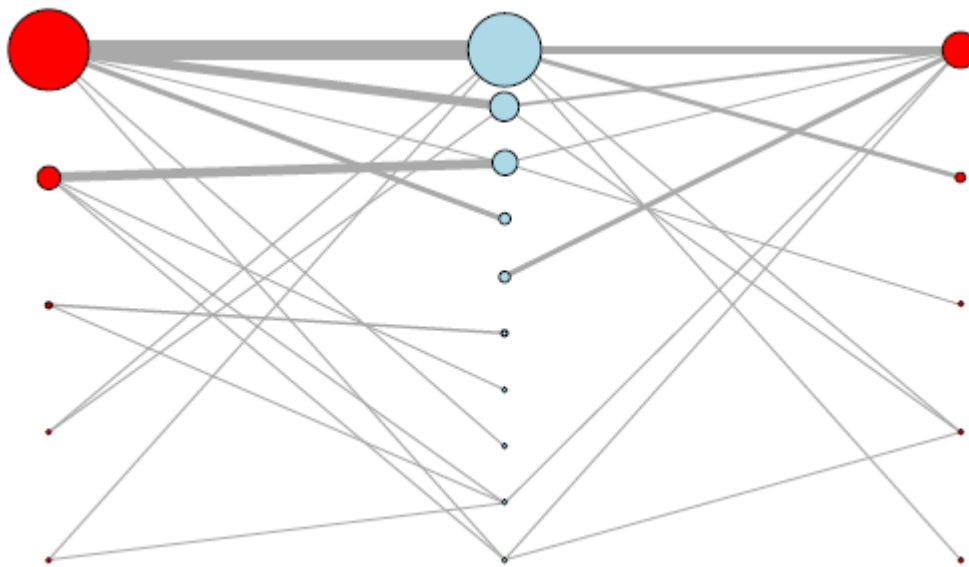
247. Custodians are another channel through which CCPs could be interconnected. The following section looks at CCPs links with custodians for cash instruments only as well as cash and non-cash instruments, also separating between USD and EUR instruments. Figure 20 analyses cash instruments held by custodians. Cash here consists of commercial bank cash, reverse repos and deposits while cash deposited at central banks is excluded. The analysis shows some level of interconnectedness through two entities in particular, including one CSD and one non-EU custodian bank.



● CCPs ○ Clearing Member Groups Largest Bubble EUR 21bn

FIGURE 20: NETWORK OF TOP-10 CUSTODIANS – CASH ONLY – ALL CURRENCIES

248. When looking at cash and securities altogether held by custodians (Figure 21), the level of interconnectedness is even higher, with a second CSD becoming very central. Figures by individual currencies are displayed in the Annex (section 6.3.2) and show the same patterns. Besides interconnectedness, dependence on a few commercial entities may be a source of operational risk concerns, especially in case of technical disruptions.



● CCPs ○ Clearing Member Groups Largest Bubble EUR 125bn

FIGURE 21: NETWORK OF TOP-10 CUSTODIANS – CASH AND SECURITIES – ALL CURRENCIES

4.2.1.3 Interconnectedness of CCPs through liquidity providers

249. As observed in the previous stress test exercise, interconnectedness through committed liquidity providers appears to be limited. Looking at resource providers with committed credit lines as well as providers of committed repos in Figure 22, we see that only a few CCPs use these committed liquidity resource providers and in most case they do so from a variety of providers. Charts in the Annex (section 6.3.3) with the breakdown by currencies (EUR and USD) show similar results.

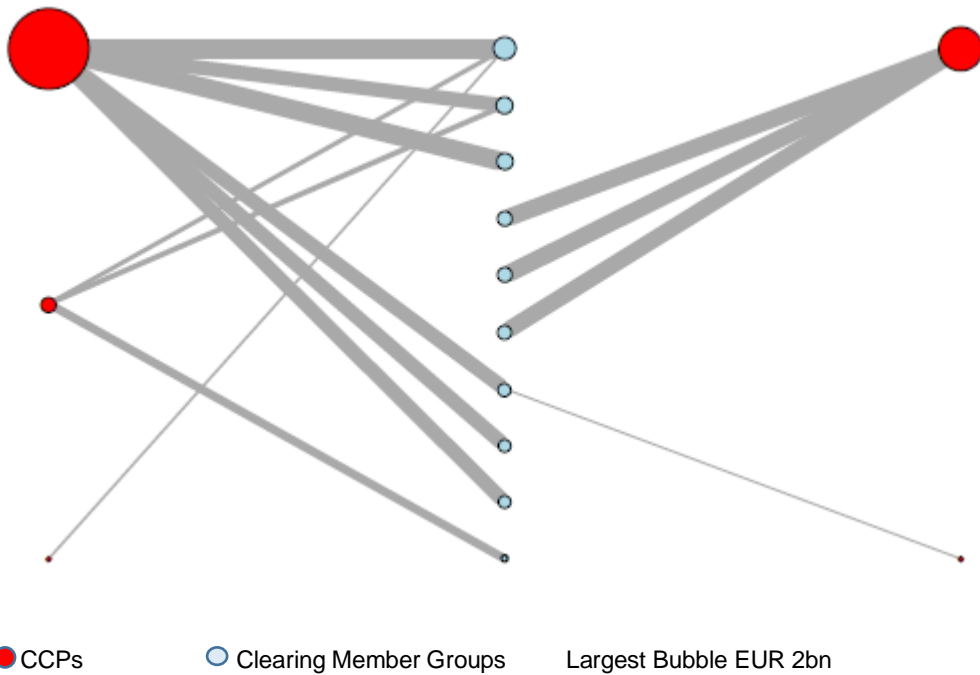


FIGURE 22: NETWORK OF TOP-10 COMMITTED LIQUIDITY LINES – ALL CURRENCIES

250. Adding uncommitted repos to the analysis, i.e. looking at credit, committed repo and uncommitted repo provision, the network seems more interconnected (Figure 23). Also, considering that some of these resource providers are clearing members at the same time, potential defaults could lead to simultaneous liquidity and credit issues that could be amplified by interconnectedness.

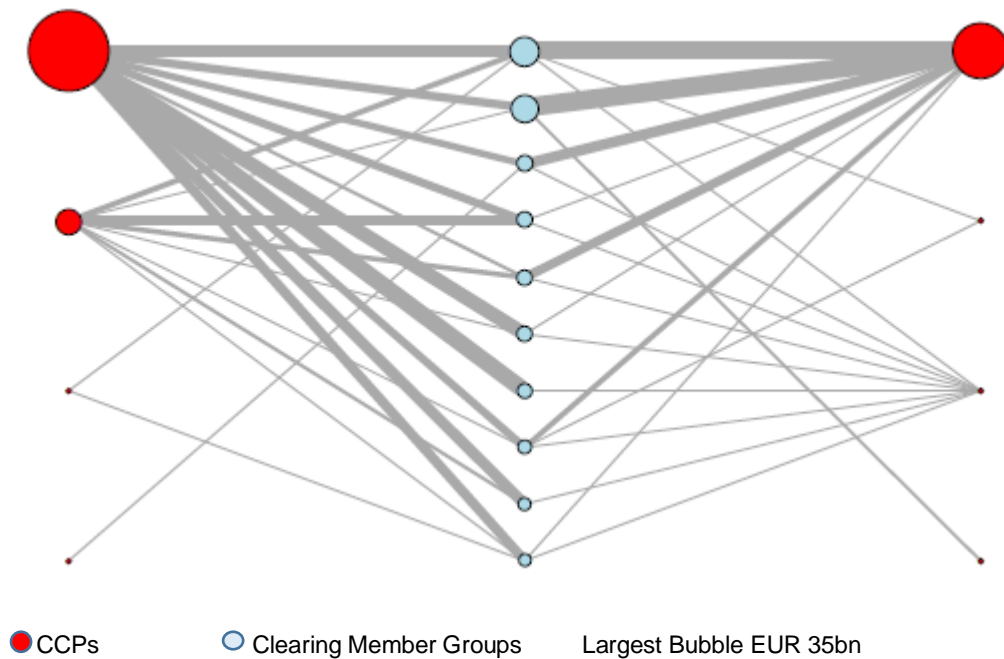


FIGURE 23: NETWORK OF TOP-10 COMMITTED CREDIT LINES AND ALL REPO PROVIDERS (COMMITTED AND UNCOMMITTED) – ALL CURRENCIES

4.2.2 Concentration of Resources

4.2.2.1 Concentration of Credit Exposures

251. As it is explained in the methodology section, the default fund contributions are used as a proxy for the credit counterparty risk assumed by the CCP towards its clearing members. Across the 16 CCP considered in the analysis there are only few for which (according to the HHI methodology and the thresholds used) the default fund contributions can be considered to be highly concentrated on a limited number of clearing members (Table 1).
252. Only two CCPs show high levels of concentration (red): ICENL and OMI, as in the previous stress test exercise. OMI displays a concentration level similar to the previous exercise – around 2.500 with the top-3 clearing members contributors being around 80% of the total. Regarding ICENL, it is important to highlight that the maximum concentration value is derived from the fact that we are using the default fund contribution to proxy the credit exposure and only one clearing member had a default fund contribution on the date of the exercise. However, ICENL reported zero credit exposures, as all open positions were cleared by this unique clearing member in the same account, and they can be netted should the member default.
253. Four CCPs appear as moderately concentrated. ATHX and KELER maintain concentration levels similar to the previous exercise (with ATHX very close to the lower bound of the threshold). ECC and KDPW increased significantly the HHI in comparison with the previous exercise. For ECC, the HHI is driven by an increase in the concentration regarding its top clearing members contributors, from around 50% to 60%. For KDPW the increase is driven by an increased weight of one of its default funds in addition to a bigger concentration of the top clearing members, from around 40% to 70%.
254. The remaining 10 CCPs show no significant concentration. LME is very close to the upper bound, due to the incorporation of a new business line and the associated new default fund which while remaining relatively small is highly concentrated.
255. Finally, overall concentration levels of credit exposures to clearing members at an EU-wide level are analysed with the EU-Wide HHI at single clearing member level and the EU-Wide HHI based on groups (Table 2). The HHI by clearing member/group is defined as the sum of the squares of the default fund share by clearing member/group across the 16 CCPs considered in the analysis. Results show that, at the EU-level, concentration levels are low and in line with the previous CCP stress test exercise. The slight increase of the HHI at Group level is due to better data quality which allowed a more detailed identification of the different clearing members groups.

HHI Weighted Average across DFs		
	2017	2019
ATHX	1,118	1,094
BME	978	980
CCG	1,005	840
CCPA	514	548
ECAG	344	312
ECC	1,071	1,573
EUROCCP	642	863
ICEEU	563	557
ICENL	7,661	10,000
KDPW	785	1,526
KELER	1,610	1,763
LCHSA	856	867
LCHUK	243	299
LME	474	999
NASDAQ	1,069	982
OMI	2,583	2,482

Note: HHI (WA) = weighted sum of HHI calculated as the sum of shares squared of default fund contributions by default fund per CCP. Weights = default fund size ratio over the total per CCP.

Red indicates significant concentration levels (>2,000); Yellow, small concentration levels (1,000-2,000); Green, no significant concentration (0-1,000). Computations at 16th September 2016 and at 8th March 2019.

TABLE 1: CONCENTRATION OF CREDIT EXPOSURES TO CLEARING MEMBERS PER CCP

	2017	2019
EU-Wide HHI LEI	152	163
EU-Wide HHI Group	286	348

TABLE 2: CONCENTRATION OF CREDIT EXPOSURES TO CLEARING MEMBERS EU-WIDE

4.2.2.2 Concentration of Liquidity Exposures

256. With respect to liquidity exposures, the HHI at CCP level is defined as the sum of squares of the share of liquid resources committed by liquidity providers within a CCP, as it is detailed in the methodology section.
257. Across the 16 CCPs considered (Table 3), there are three CCPs for which liquidity resources can be considered highly concentrated. ATHX liquidity concentration triples compared with the previous exercise. This is due to the increase in the share of the top-one liquidity provider which is the CCP, from around 20% in the last exercise to more than 60% in this one. ICENL concentration, while still high, has decreased as the share of its top one liquidity provider has decreased, from more than 75% to around 50%. Concentration for OMI has more than doubled, due to the increased weight of its top-3 liquidity providers, approximately from 50% to 80%.
258. Four CCPs show low concentration. Concentration for ECC is similar compared to the previous exercise. CCG liquidity concentration has also increased sharply from very low levels, but still remains within the low concentration category. We see an increase in the concentration of the top-3 liquidity providers (from 30% to more than 40%, approximately), partly also because of the methodological change and the fact that CCG shows higher reliance on the liquidity provided by the interoperable CCP. However this does not reflect actual funding. The interoperable activity is a significant part of the overall activity of CCG and the resources that are forwarded to the interoperable CCP are now excluded with the new methodological change. CCPA liquidity concentration has decreased, mainly because of a decrease in the concentration of the top-3 liquidity providers, from almost 60% to less than 50% now. Finally, EUROCCP concentration has increased due to an increase in the concentration of the top-3 liquidity resource providers, approximately from 35% to 50%.
259. Nine (9) CCPs show no significant liquidity concentration levels. Concentration for KELER declined from low to no significant concentration due to an increase in the number of liquid resources providers and an decrease in the top-one provider from more than 25% to approximately 15%. Concentration for NASDAQ has increased due to a minor number of liquid resources providers and an increase of the top-3 providers from less than 30% to almost 35%. LCHSA and LCHUK show similar concentration levels as in the last CCP stress test exercise.
260. From an aggregated perspective, overall concentration levels of liquidity exposures at an EU-wide level (Table 4) are analysed with the EU-Wide HHI at single liquidity provider level and the EU-Wide HHI based on group liquid resources. Results show that, at the EU-level, concentration levels are low.

HHI Liquidity exposures		
	2017 with interop.	2019 without interop.
ATHX	1,227	3,938
BME	604	571
CCG	563	1,663
CCPA	1,413	1,024
ECAG	510	435
ECC	1,905	1,940
EUROCCP	815	1,217
ICEEU	458	458
ICENL	6,284	4,203
KDPW	748	804
KELER	1,166	819
LCHSA	506	476
LCHUK	247	318
LME	513	517
NASDAQ	456	636
OMI	1,431	3,068

Note: HHI = sum of shares squared of liquidity provider per CCP. Share expressed in terms of total liquidity resources provided in EUR.

Red indicates significant concentration levels (>2,000); Yellow, small concentration levels (1,000-2,000); Green, no significant concentration (0-1,000).

Computations at 16th September 2016 and at 8th March 2019.

TABLE 3: CONCENTRATION OF LIQUIDITY EXPOSURES

	2017	2019
EU-Wide HHI LEI	180	209
EU-Wide HHI Group	360	413

TABLE 4: CONCENTRATION OF LIQUIDITY EXPOSURES AT EU-WIDE LEVEL

4.3 Credit Stress Test Results

261. In this section we present the credit stress test results as combinations of the member default scenarios with the market stress scenario. First, we present the cover-2 per CCP results where we assume the default of two clearing member groups separately at each CCP and then the EU-wide cover-2 results, where we assume the default of two groups EU-wide, i.e. the same two groups for all CCPs. The methodology used in the credit stress test including the design and assumptions of the scenarios is detailed in Section 3.4.
262. In all cases, the results of the credit stress test are presented for the two different dates that are covered in this exercise²⁸. The losses are always a result of simultaneous clearing member defaults and adverse changes of market prices. From a credit risk perspective, a combination of clearing member defaults and simultaneous severe shifts of risk factor prices is needed to put a CCP at risk. If clearing members continue to post margin and meet their obligations, periods of extreme market volatility in isolation will not pose a specific market risk to a CCP. Similarly, defaults of clearing members without simultaneous adverse market shocks should not put a CCP at risk. Clearing members post margins and default fund contributions scaled to a very high confidence level. This should make sure that CCPs have sufficient resources to manage a default of a clearing member in normal market conditions, and close out the resulting open positions in a stable market before suffering a loss. Therefore, under normal market conditions, the CCPs will have the resources to withstand multiple defaults. Hence, from a credit risk perspective and with the exception of investment risks, only simultaneous defaults and extreme, adverse shifts of market prices could pose potential risks to a CCP.
263. The selection of defaulters is based on corporate groups. Hence, we can have more than two clearing members defaulting at each CCP. Moreover, for CCPs that have more than one default fund, the clearing members belonging to those groups, may or may not be active in more than one default fund.

4.3.1 Cover-2 per CCP Credit Stress Test Results

264. The “Cover-2 groups per CCP” credit stress test is designed to assess the resilience of each CCP independently to the Market Stress Scenario, focusing on the worst outcome for each CCP.
265. In accordance with the methodology, we select for each CCP individually two (2) corporate groups and assume all the clearing members belonging to those 2 groups as defaulting in the same CCP. The selected clearing member groups and defaulting entities will be different for each CCP and are not considered to be in default in other CCPs. The results for each CCP come from an independent selection of defaulting groups that don't propagate to other CCPs, therefore the interpretation should be limited to the assessment of the resilience of individual CCPs under a common market stress scenario.
266. As explained in the methodology section, the selection is performed using two sequential criteria, the second one acting as a fall-back in case there is no case that satisfies the first criterion:
- Maximize the shortfall of prefunded resources: The groups selected for each CCP are the ones whose default would lead to the highest resource consumption measured in monetary amount (EUR) beyond required margin collateral and above the total prefunded mutualised resources,

²⁸ i.e. 21 December 2018 and 8 March 2019

including the total default fund, the dedicated resources (“skin-in-the-game”) and other prefunded Default-Fund-level resources.

- Maximize the overall consumption of prefunded resources: If no shortfall is to be found, the groups selected for each CCP are the ones whose default would produce the highest loss above required margin collateral, measured in monetary amount (EUR).

267. For the Cover-2 per CCP results, additional analyses are provided in order to enhance the insights from the Stress Test exercise:

- *Analysis of Cover-2 group combinations that cause high percentual (%) consumption:* This analysis highlights combinations of defaulting groups that would cause a % consumption of a default fund close to causing a shortfall but that are not presented in the main cover-2 results as the loss in (EUR) monetary terms is inferior to the main results. The rationale of presenting this additional analysis to complement the main results is to ensure that the focus on the highest loss amounts and the consistency in applying the same metric to all CCPs doesn't prevent us from highlighting any result that could indicate a weakness in smaller default funds and could warrant supervisory attention.
- *Analysis of the sensitivity of the Cover-2 per CCP results to changes in the underlying shocks:* This analysis presents the estimated impact of changes in the market shocks. The reason for it is to understand if small changes to the underlying shocks could significantly impact the Cover-2 per CCP results.

BOX 3: DESCRIPTION OF THE CREDIT STRESS TEST CHART

The credit stress test results are always presented in the form of a Panel, showing for each CCP the following (from bottom to top):

Amounts of default waterfall consumption (in mil. EUR)

- Loss covered with DF, SITG and other DF-level Resources: Amount of stress loss (in million EUR) covered with the Default Fund (including defaulting and non-defaulting members' contributions), dedicated CCP resources ("skin-in-the-game") and other prefunded and committed Default-Fund-level Resources that the CCP may have. Where the CCP has more than one Default Fund, this amount is the sum of amounts calculated per Default Fund. It is illustrated in green in the chart.
- Loss covered with other CCP-level Resources: Amount of stress loss (in million EUR) covered with other prefunded and committed CCP-level resources, where applicable. The CCP-level resources are resources that can be used across default funds where the CCP has more than one default funds. It is illustrated in yellow in the chart.
- Loss covered with PoA: Amount of stress loss (in million EUR) that would need to be covered with non-prefunded resources (powers of assessment). Where the CCP has more than one Default Fund, this amount is the sum of amounts calculated per Default Fund. Only the non-defaulting members are assumed to provide additional non-prefunded resources. It is illustrated in red in the chart.
- Loss after PoA: Amount of stress loss (in million EUR) left uncovered after using prefunded and non-prefunded resources. This amount is again the sum of all uncovered amounts where the CCP has more than one Default Funds. It is illustrated in black in the chart.

% Consumption of Resources

- % Consumption of the Default Fund (including the defaulters' contributions), the skin-in-the-game and other prefunded and committed Default-Fund-level Resources that the CCP may have. For CCPs that have more than one default funds, the maximum % consumption is presented.
- % Consumption of Powers of Assessments (called only from non-defaulting members). For CCPs that have more than one default funds, the maximum % consumption is presented

Two flags

- A flag indicating (in red) whether non-prefunded resources would have to be used.
- A flag (top of the panel) indicating (in black) whether there would be uncovered losses after using also non-prefunded resources.

4.3.1.1 Cover-2 per CCP Results for March 2019

Cover-2 Groups per CCP (no cross defaulting) Date: March 2019 – Without Excess Margin

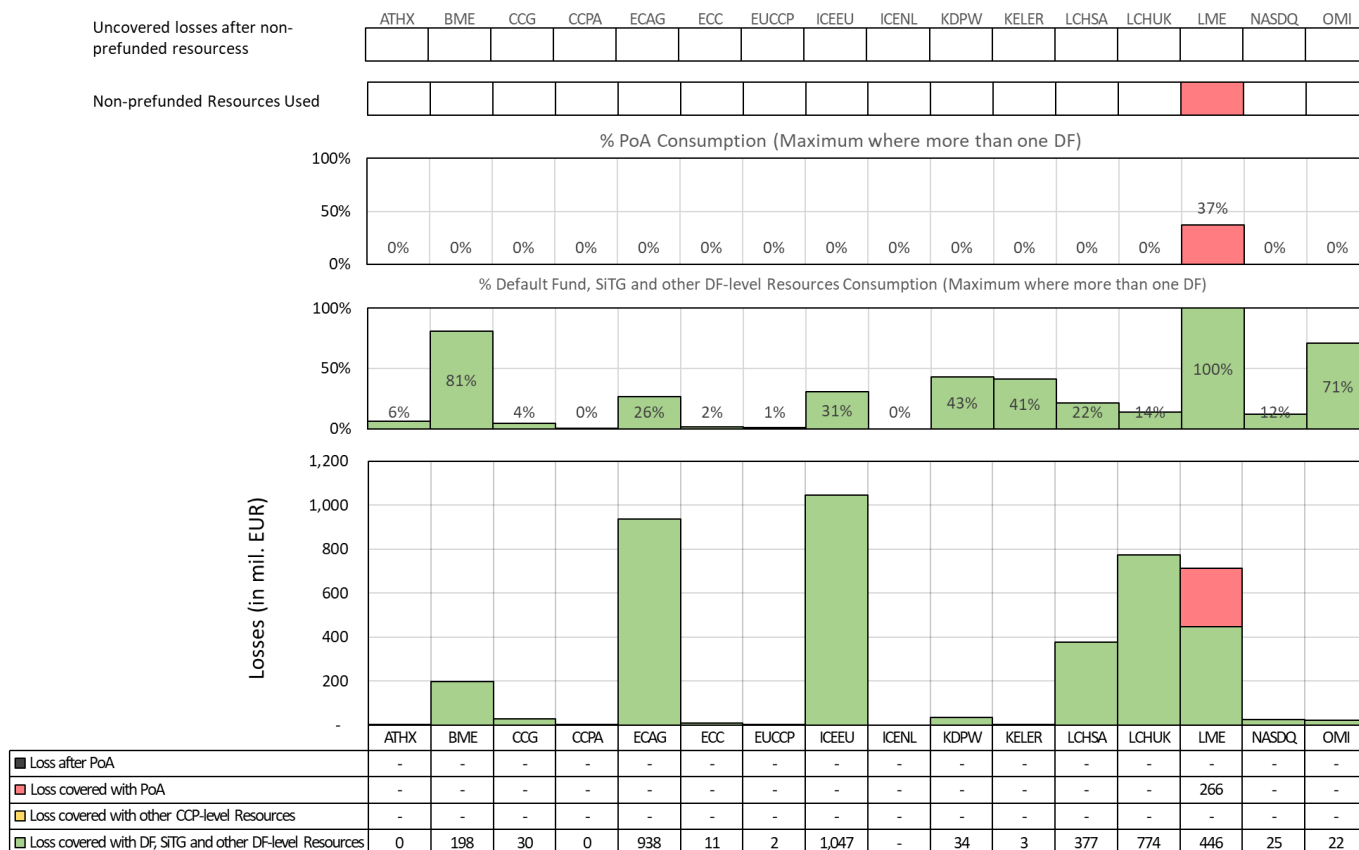


FIGURE 24: COVER-2 GROUPS PER CCP – DATE: MARCH 2019 – WITHOUT EXCESS MARGIN

268. For the March date, we see at one CCP (LME) a shortfall of the prefunded Resources that would be available to cover the default of two of its clearing member groups. In practice this means that, following the default of two clearing member groups under the adverse market stress scenarios, this CCP would have to use all 446 million EUR of prefunded resources corresponding to default fund and skin-in-the-game, leaving approximately 266 million EUR of residual losses. These residual losses would have to be covered with additional non-prefunded resources that the CCP has the right to call from its non-defaulting members, leaving no losses uncovered. This hypothetical event would involve the default of three clearing members belonging to two groups. The default of any single clearing member group would not lead to any shortfall of prefunded resources, but the simultaneous default of the second and third largest groups would also lead to a shortfall, though smaller. From a market stress scenario perspective, this theoretical shortfall is the result of simultaneous and extremely severe downward shocks to different underlyings.

269. For the same date, we see that two other CCPs face more than 50% of consumption of available prefunded resources beyond required margins, namely: BME with a maximum % consumption of 81% at one of its default funds, and OMI with a consumption of 71% at its single default fund.

270. In terms of losses in monetary (EUR) amounts, the losses are naturally higher at the bigger CCPs with the two largest amounts found at ICEEU with 1,047 million EUR and ECAG with 938 million EUR. Yet both CCPs have sufficient prefunded resources to cover such losses, with maximum % consumption close to 30%.
271. As explained in the resources section, one of the CCPs (ICENL), reported zero losses because the open positions were cleared by one clearing member in the same account and can actually be netted on both dates should the member default. The stress test had therefore no impact on this CCP and the stress exposures are always reported as zero. This fact reflects the reported exposures for these particular dates and is no indication for the resilience of its risk management arrangements should an exposure exist.
272. Overall, aggregating the independent cover-2 results of the different CCPs there is a volume of approximately 4.2 billion EUR of losses after required margin and 2.9 billion EUR of losses after required margin and defaulters' default fund contributions. These amounts give an indication of how impactful the scenario is, but it should be noted that this is not a scenario that could be realised at the same time across all CCPs. It aggregates the worst results that were produced per CCP and assumes the default of different groups at different CCP.
273. Given that the Stress Test scenario for the March date generated a shortfall of prefunded resources, the results using excess margin have also been analysed. The excess margin collateral consists of assets that were actually available at the CCPs on these particular dates. It was provided by the clearing members in excess of the required amounts. The rationale of not including excess collateral in the base scenarios is that it would not be prudent to assume that a member in default would have actually provided on the previous day any collateral in excess of the minimum requirement. We nevertheless report the results considering the excess margin for completeness in order to show what the actual impact would be from the same defaults if all else is assumed unchanged.
274. The cover-2 per CCP results for the March date are reported in Figure 25. The selection of top groups and defaulting entities is always performed using only the required margin collateral. The same defaulting entities are considered when reporting the results with total (i.e. including excess) collateral.

Cover-2 Groups per CCP (no cross defaulting) Date: March 2019 – With Excess Margin

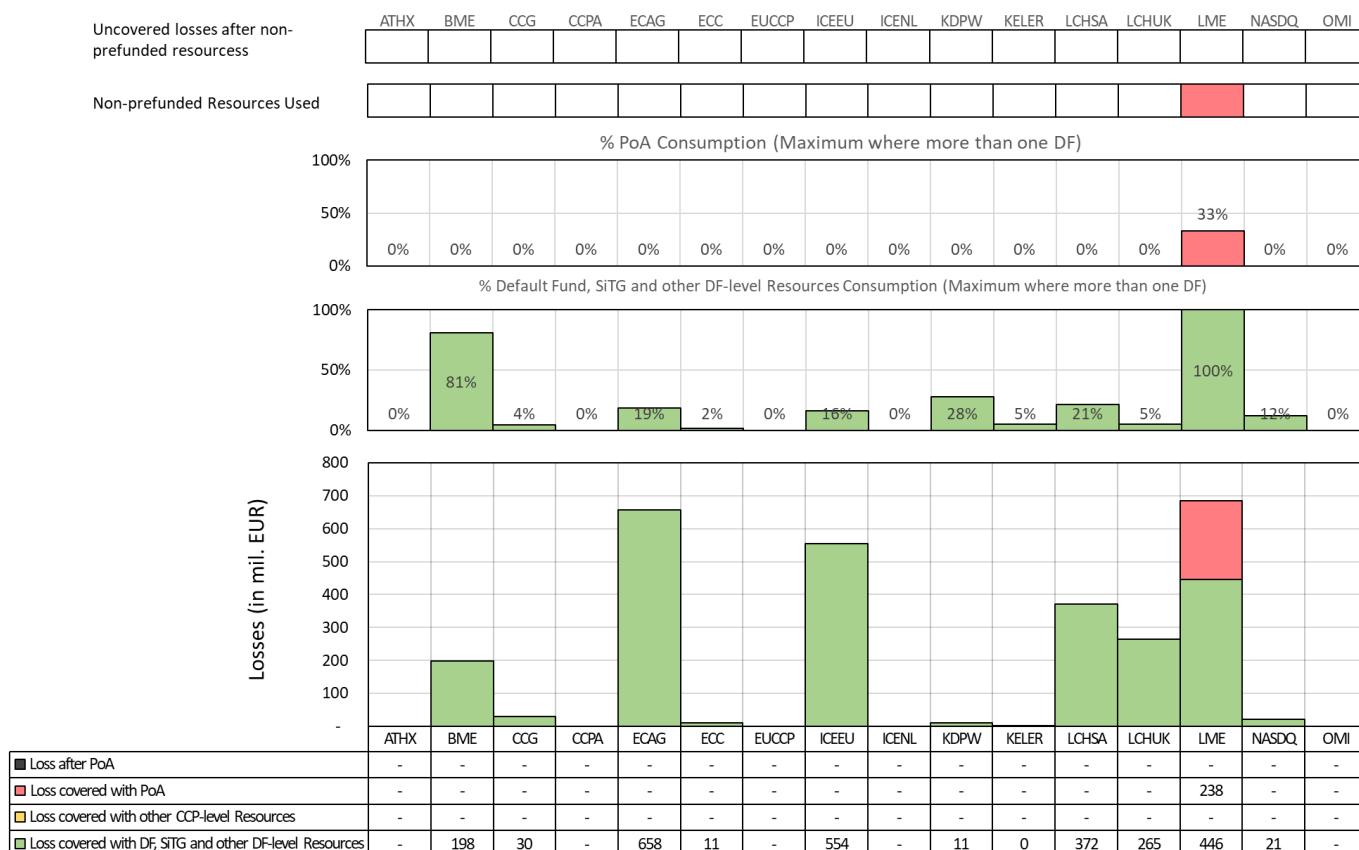


FIGURE 25: COVER-2 GROUPS PER CCP – DATE: MARCH 2019 – WITH EXCESS MARGIN

275. Taking into account the excess margin, there would still be a shortfall under the cover-2 per CCP scenario at one CCP (LME), but for a smaller amount. The loss above prefunded resources is now estimated to 238 million EUR, compared to the 266 million EUR considering only the required margin.

276. For the rest of CCPs, the impact is generally more reduced, with only one CCP (BME) consuming over 50% of the prefunded resources of one of its default funds, and five CCPs where losses would be covered using only required and excess margin²⁹ of the defaulting members. Overall, aggregating the independent cover-2 results of the different CCPs the volume of resources above margin that would be consumed decreased to approximately 2.8 billion EUR, compared to the 4.2 billion EUR calculated using the required margin.

²⁹ One CCP (ICENL) reported no loss on the reference dates of the exercise.

4.3.1.2 Cover-2 per CCP Results for December 2018

Cover-2 Groups per CCP (no cross defaulting) Date: December 2018 – Without Excess Margin

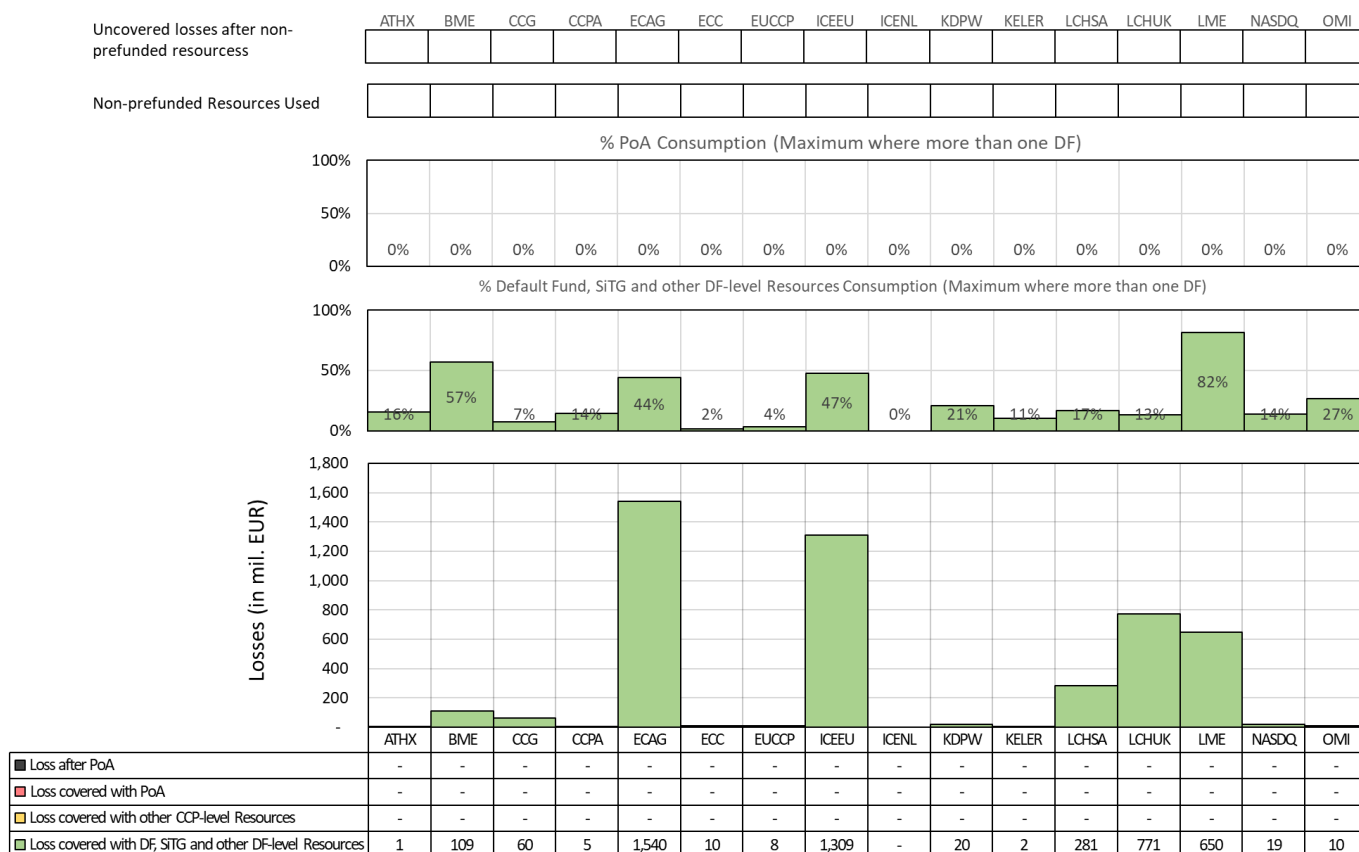


FIGURE 26: COVER-2 GROUPS PER CCP – DATE: DECEMBER 2018 – WITHOUT EXCESS MARGIN

277. For the December date, the cover-2 per CCP scenario does not generate a shortfall of prefunded Resources at any CCP. However, in aggregate across all CCPs, the scenario generates more losses over required margin, i.e. 4.8 billion EUR compared to 4.2 billion EUR calculated for the March date. Also, the impact on non-defaulting members is higher, since the losses after exhausting the defaulters' resources are 3.3 billion EUR compared to 2.9 billion EUR for March. This is mainly the result of higher losses amounts for the two CCPs that have again the two largest losses above margin, i.e. ECAG with 1.5 billion EUR and ICEEU with 1.3 billion EUR. In both cases, also the maximum % consumption of prefunded resources is higher, but still lower than 50%.
278. For the two CCPs that had the two largest % consumptions on the March date (BME and OMI), we now see lower consumptions both in terms of monetary (EUR) amounts and in percentage terms. For BME the % consumption is now 57% and for OMI 27%.
279. Finally, with regards to the CCP (LME) that would have a shortfall of prefunded resources for March, there is no shortfall for December. The losses calculated for December are fully covered with the prefunded resources that were available for the same date. On both dates we have identified the same two clearing member groups as the top-2 defaulting groups of this CCP. Of course, the

positions differ between the two dates. Moreover, although the % stress shocks applied on both dates are the same (EU-wide scenario), the different level of prices may have led to a different impact³⁰. The losses above margin for December are lower, i.e. 650 million EUR compared to 713 million EUR for March. However, what makes a difference is that at the same time the prefunded resources available to cover the losses are significantly higher. In particular, the default fund, from which the losses originate, was reduced by approximately 45% from December to March.

4.3.1.3 Cover-2 per CCP results using an alternative selection criterion

280. We have conducted additional analysis to investigate how the results would look if we selected the groups that would cause the highest percentual (%) consumption within one default fund, instead of the highest monetary (EUR) loss at CCP level. The motive is to investigate if there are any smaller default funds that could experience higher % consumption, putting them close to a shortfall, and could thus warrant attention.
281. For CCPs that have multiple services organised in different default funds, the default fund contributions and skin-in-the-game resources allocated to each default fund can only be used within the same default fund. Therefore, a CCP that has more than one default funds could experience a shortfall of prefunded resources for a smaller default fund, even if it is exposed to lower losses. The selection and results using this alternative selection method will be the same for CCPs that have only one default fund.
282. For December 2018, the maximum % consumption changes for five CCPs, but only for two CCPs out of these five there is a change that is rather significant³¹. For one CCP (BME) the % consumption of prefunded resources for a smaller default fund is found to be 95%, compared to the 57% we reported for the same CCP but another default fund when we are maximising the amount (EUR) of losses. In particular, the 25 million EUR of losses above margin are enough to lead to this high consumption of available resources for this default fund. For another CCP (NASDAQ) we also have a significant increase of the maximum % consumption from 14% to 52%, again coming from a different and smaller default fund, accompanied with very small losses over margin (2 million EUR).
283. For March 2019, the maximum % consumption of prefunded resources increases for three CCPs, but again only for one CCP (NASDAQ) we have a change that is significant, at least in terms of % consumption. For this CCP and the same small default fund identified for December we have very small losses above margin, i.e. 3 million EUR, that are enough to lead to a high % consumption of 88% for this default fund.
284. This alternative selection method highlights two smaller default funds for which the scenario would cause a high % consumption of the available prefunded resources. This shows that the impact of the stress scenarios is higher for these services, which could warrant additional attention. However, in both cases the prefunded resources are enough to cover the calculated losses. Moreover, the default funds and the driving losses are small and cannot raise any systemic concerns.

4.3.1.4 Sensitivity of Cover-2 per CCP Results

285. This additional analysis discusses the impact of small changes to the underlying shocks on the

³⁰ For example, the same 10% shock would lead to a loss of 100 EUR when the price is 1,000 EUR and to a loss of 150 EUR when the price is 1,500 EUR.

³¹ A significant change is defined for the purpose of this analysis as an increase of the consumption by more than 15%, e.g. from 50% to 65%.

Cover-2 per CCP results. The CCPs were asked to report the results not only for the market stress scenario shocks, but also after applying a number of multipliers on the shocks (i.e. x0.7, x 1.2, x1.5 and x2.0). For each value of the multiplier, the CCPs ran a full repricing of the portfolios, as opposed to applying a multiplier to the result (P&L) of the scenario. All shocks are simultaneously scaled for all risk factors. So, for example, we can calculate the results after adjusting all shocks by +20%, but it is not possible to have the results after adjusting only individual risk factors. For cases where products belonging in one asset class are cleared in separate default funds, we could estimate the impact for these asset classes alone.

286. Assuming moves that are 30% less severe than the defined stress shocks, we see that there would not be any shortfall of prefunded resources, on both dates. Of course, the resulting shocks are very low and in the vast majority of the cases less severe than the maximum historic moves. The magnitude of these shocks would not be suitable for a Stress Testing exercise that is designed to test the resilience of CCPs resources. The very limited severity in the majority of the cases is reflected in the very limited impact that such shocks would have on the CCPs. The CCPs are required to size their resources considering potential future scenarios and a range of historical scenarios, including periods of extreme market movements observed over the past 30 years, or as long as reliable data have been available, that would have exposed them to greatest financial risk. The reduced shocks would lead for March to only 1.1 billion EUR (4.2 billion EUR under the base scenarios) of losses after margin and less than 0.5 billion EUR (2.9 billion EUR under the base scenarios) of losses after defaulters' resources. For both dates, and with the exception of one CCP that is different for each date, no more than 25% of the prefunded resources would be consumed at any other CCP.
287. If instead one would assume higher shocks than those included in the scenarios, the results would be significantly more severe. Considering the severity of the shocks and the fact that we go beyond what was considered as extreme but plausible in the context of this exercise, it should be noted that the rationale of this analysis is not to put the focus on specific CCPs but rather investigate if relatively small increases of the shocks could lead to systemically relevant changes on the results of individual CCPs. A similar analysis is performed under the reverse stress test component where we expand in two dimensions, being the severity of the shocks and the number of defaulting groups. The key difference is that in the reverse stress analysis we focus on the internally consistent EU-wide member default scenarios, i.e. select the same groups as defaulting across all CCPs. Here we select the worst two groups per CCP and thus try to identify any systemically relevant impact at individual CCPs. For March, if one would assume moves that are 20% more severe than the baseline stress shocks, there would be a theoretical shortfall at 3 CCPs, ranging between 1 million EUR and 594 million EUR. Similarly, for December we would have a theoretical shortfall at 2 CCPs, with an aggregate shortfall of 184 million EUR, coming mainly from one of the two CCPs. As explained, considering the fact that we go beyond what was considered as extreme but plausible, this analysis should be read with caution. The results would not raise any additional, systemically relevant concern at individual CCPs. However, the increased sensitivity that we see in some cases for individual CCPs deserves further attention.

4.3.2 EU-wide Cover-2 Credit Stress Test Results

288. The "EU-wide Cover-2" credit stress test is designed to assess the resilience of CCPs collectively to the Market Stress Scenario, focusing on the worst outcome for the whole system of CCPs.
289. As explained in the methodology detailed in section 3.4.2, the same two groups of clearing members are assumed to be in default in all CCPs. The selection of defaulting groups is based on the impact

to prefunded resources at EU-wide level, considering all CCPs. Given that the selection of defaulters is the same for all CCPs, the results illustrate what would be the systemic effect of the most impactful default of two groups at an EU-wide level and how it would affect each CCP. The default of two clearing member groups EU-wide in combination with stress market conditions can be considered as an extreme but plausible scenario.

290. The EU-wide Cover-2 stress test allows to show both the combination of defaulting groups that would cause the highest consumption of prefunded resources at an EU-Wide level, as well as understanding the implications of the highest shortfall of prefunded resources and its impact on other CCPs. We will thus present results using the following two selection methods:

- *Maximize the shortfall of prefunded resources:* The groups selected are the ones whose default would lead to the highest aggregate shortfall of prefunded resources across all CCPs³². The result with this selection focuses on the combination of defaulting groups that would cause the highest shortfall amount from an EU-Wide perspective and reports how it would affect the different CCPs. However, as expected, this selection method focuses on a shortfall for one CCP (that is already presented under the cover-2 groups per CCP scenario) and propagates to all other CCPs the default of the same two clearing member groups. The results are useful to see what would happen at an EU-wide level as a result of the default of the two Groups that led to the shortfall at one CCP. However, a second selection method is needed to try to identify an event that could impact multiple CCPs at the same time.
- *Maximize overall impact:* The groups selected are the ones whose default would produce the highest aggregate (EUR) loss beyond required margin across all CCPs. The result with this selection illustrates the pair of groups that would cause the most losses in all CCPs collectively.

291. The EU-wide Cover-2 results are reported separately for the two dates, based on the same format that was used for the Cover-2 per CCP results.

4.3.2.1 EU-wide Cover-2 Results for March 2019

292. The EU-wide cover-2 results after selecting the two groups that would maximize the shortfall of prefunded resources are reported in the figure below (Figure 27).

³² Similar to the Cover-2 per CCP case, the shortfall is measured as the resource consumption in monetary (EUR) amount beyond required margin collateral and above the total prefunded mutualised resources, including the default fund, the dedicated resources ("skin-in-the-game") and any other available prefunded & committed DF-level resources.

295. Overall, the EU-wide impact of this combination of defaulting groups is approximately 1.6 billion EUR of losses after margin and 1.2 billion EUR of losses after defaulter's margin and default fund contribution.

296. The EU-wide Cover-2 results after selecting for the groups that would maximize the overall impact, without necessarily focusing on the ones that would create the maximum shortfall, are reported in the figure below (Figure 28).

EU-wide Cover-2 (top-2 groups EU-wide, defaulting at all CCPs) Date: March 2019 - Without Excess Margin - Maximize overall impact

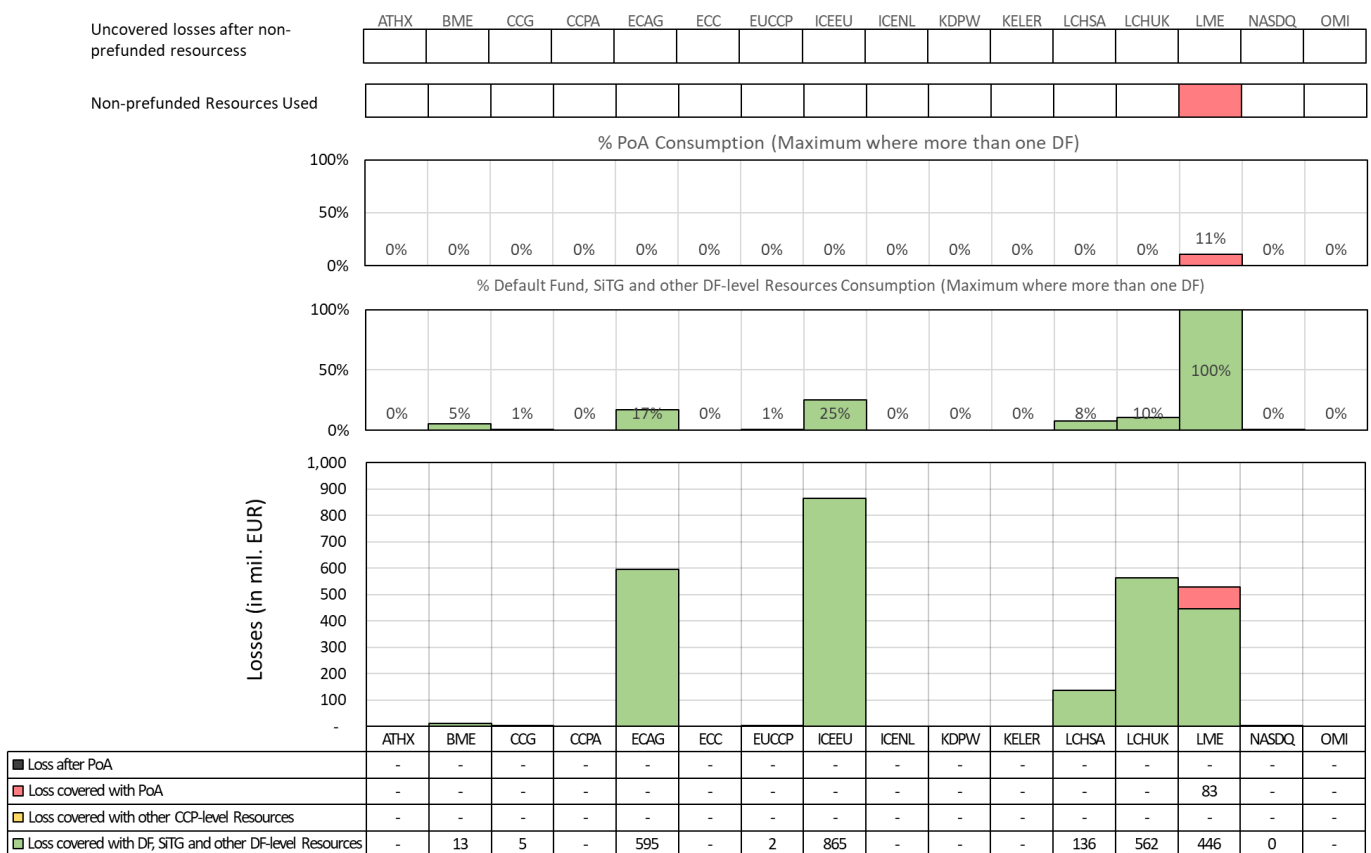


FIGURE 28: EU-WIDE COVER-2 – MARCH 2019 – WITHOUT EXCESS MARGIN – MAXIMIZE OVERALL IMPACT

297. The combination of defaulting groups selected for the March 2019 date by searching for the highest aggregate (EUR) loss beyond Required Margin still produces a shortfall of prefunded resources for one CCP (LME), though a smaller one. The algorithm selected a different pair of defaulting groups (one of the groups is still the same), leading to a shortfall of approximately 83 million EUR for the same CCP.

298. Three CCPs are not impacted at all by the defaults as they have no members belonging to the defaulting groups. For the remaining thirteen CCPs that are impacted by the default, we have identified one to twelve members belonging to at least one of the two defaulting groups. This shows that the default of a single clearing member group can lead to a surprisingly large number of

individual members defaulting. As expected, the results are less impactful for the one CCP, as the algorithm does not focus on maximising the shortfall, but on being more impactful for the remaining CCPs. Except for the CCP that has the shortfall, the scenario does not consume more than 25% of prefunded resources.

299. Overall, the EU-wide impact of this combination of defaulting groups is approximately 2.7 billion EUR of losses after margin and 2.2 billion EUR of losses after defaulter's margin and default fund contribution.

4.3.2.2 EU-wide Cover-2 Results for December 2018

300. The combination of defaulting groups selected in the December 2018 date by searching for the highest aggregate (EUR) loss beyond Required Margin do not produce a shortfall in any CCP. This is an expected result as there was no shortfall detected in the cover-2 per CCP results which already maximises the impact per individual CCP. This is also the reason why the "Maximize the Shortfall" results for the December 2018 date are not presented.

301. The EU-wide cover-2 results after selecting for the groups that would maximize the overall impact, are presented in the figure below (Figure 29).

EU-wide Cover-2 (top-2 groups EU-wide, defaulting at all CCPs) Date: December 2018 - Without Excess Margin - Maximize overall impact

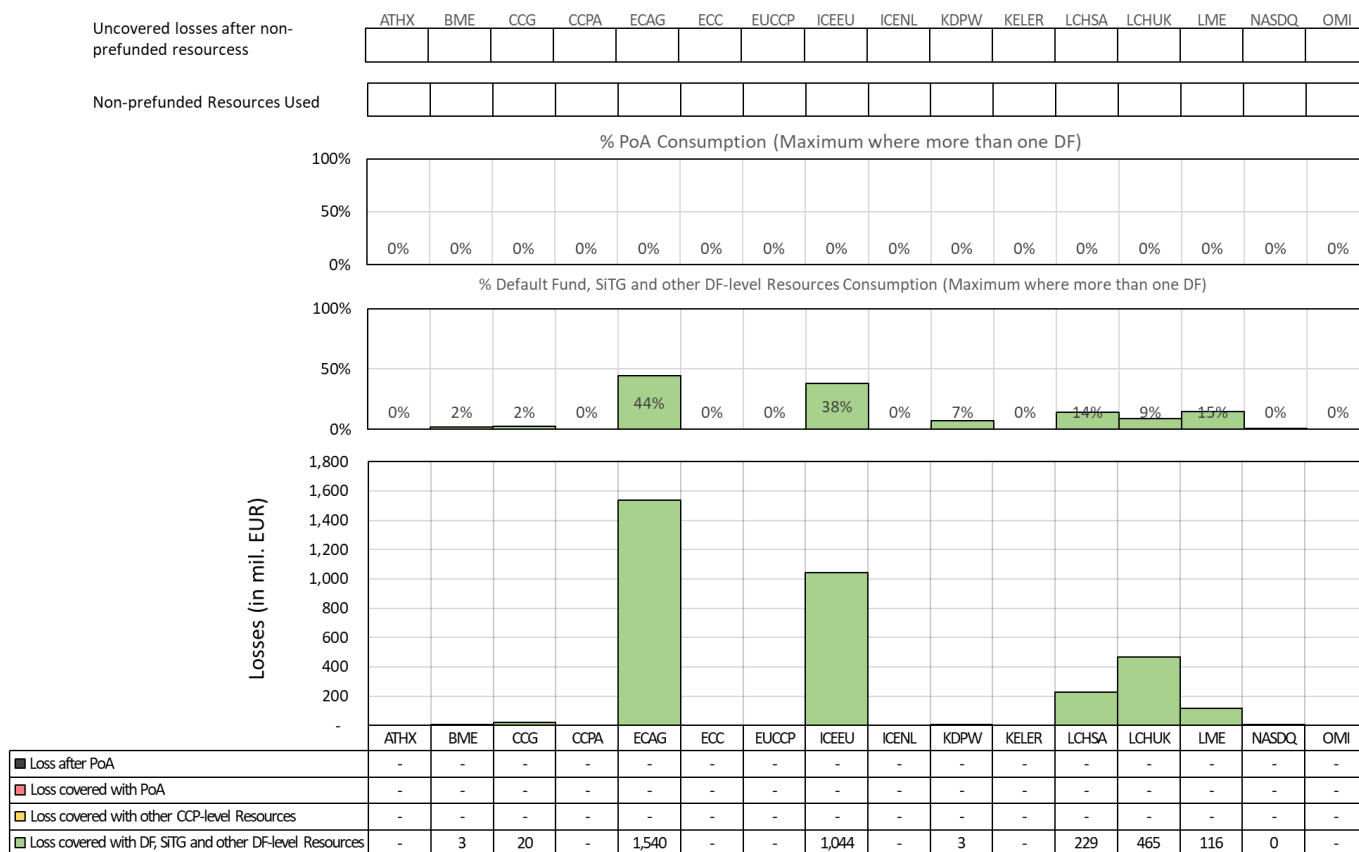


FIGURE 29: EU-WIDE COVER-2 – DECEMBER 2018 – WITHOUT EXCESS MARGIN – MAXIMIZE OVERALL IMPACT

302. The overall consumption of resources is higher compared to the corresponding March results, with the majority of losses stemming from two of the bigger CCPs. The reason is that the algorithm selected the groups that would be more relevant across multiple CCPs and focused on a specific pair of clearing member groups that would maximise the loss. The % consumption of the most impacted CCPs is still below 50%, while for the rest of CCPs it is below 15%.
303. Overall, this combination of defaulting groups would lead to at least one default for thirteen CCPs, with the number of single defaulting entities ranging from one to nine per CCP and an impact of approximately 3.4 billion EUR of losses after margin and 2.3 billion EUR of losses after defaulter's margin and default fund contribution.
304. The sensitivity of the results from the EU-wide member default scenarios are analysed as part of the reverse stress test (section 0). Moreover, the impact on non-defaulting members is discussed in the following section.

4.3.2.3 Clearing Member Knock-on Analysis

305. The aim of this analysis is to assess whether there are potential systemic risk implications from non-defaulting clearing members losing resources because of the loss sharing mechanism of CCPs. In case of default, if the defaulters' resources and the CCP's skin-in-the-game are not enough to cover the loss, the CCP will use the non-defaulting members' default fund contributions. If these are exhausted, and subject to its rules, the CCP may call for additional non-prefunded resources. In such an extreme scenario, single entities could lose at multiple CCPs their respective default fund contributions, and at the same time be called to provide within a very short time horizon additional resources.
306. We have calculated for all clearing members the amount of prefunded and non-prefunded resources that would be lost under the different EU-wide member default scenarios. We only perform this analysis for the EU-wide cover-2 scenarios, as for these we have the same entities assumed to be in default across all CCPs. The analysis is based on the required collateral (excluding excess). In order to focus on cases where the impact could be material in a systemic risk context, we have first identified the non-defaulting members for which the aggregate loss, originating from prefunded and non-prefunded resources within one scenario, would exceed 10 million EUR.
307. In order to introduce a measure of how important this loss could be for individual entities, we have asked the CCPs via the data request to report the capital figures³³ for their clearing members. As it was first identified in the previous exercise, and confirmed again in this exercise, the quality of the capital data received was not satisfactory. In several cases we had different amounts from different CCPs for the same entities, capital type and reporting periods. For the purpose of this analysis we favoured the use of the most recent CET1, where it was reported, and to the extent possible, tried to validate the numbers, at least for the top exposures. A level of uncertainty still exists, but this should not challenge the overall high-level conclusions. The exercise is not performed at the group level, as (a) group capital figures are not available, (b) we would need to incorporate the structure and absorb capital at different entity levels, and (c) we would need to assume that parent companies

³³ Where the CCP was not in a position to report CET1, it would have to report Tier 1 and if Tier 1 is not available either, it would have to report Total Regulatory Capital.

would be willing to absorb losses.

308. After identifying the entities with the highest losses (> 10 million EUR), we filtered for the clearing members where the aggregate loss (across CCPs) would also exceed 5% of their capital for any of the scenarios.

309. In the following figure (Figure 30), we present the results. The blue bar indicates the amount of losses stemming from the use of prefunded resources (default fund contributions) and the orange bar the amount of non-prefunded resources that would have to be called by CCPs and used to cover losses of other members. The aggregate loss is also expressed as a percentage (%) of the member's capital.

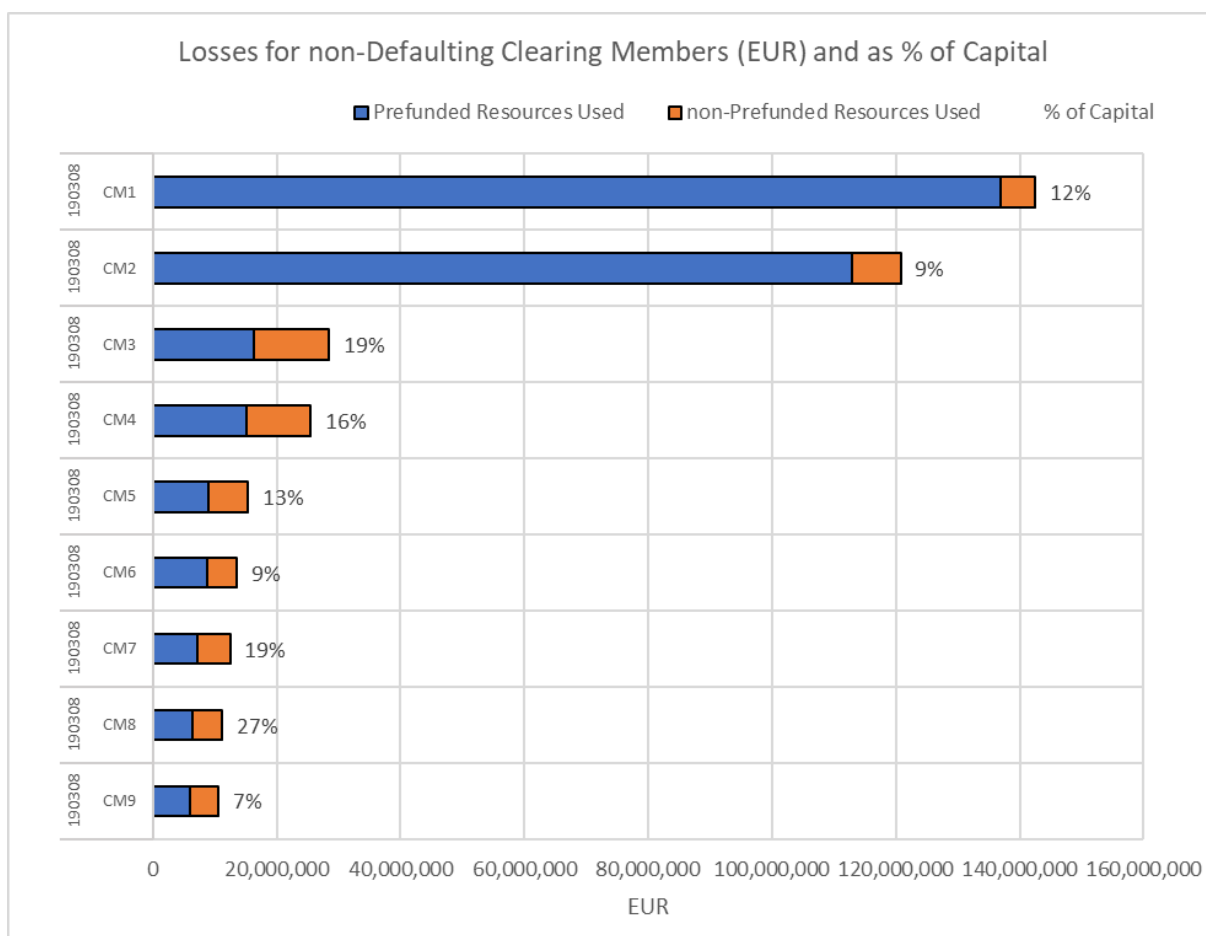


FIGURE 30: MEMBER KNOCK-ON ANALYSIS – IMPACT ON NON-DEFAULTING CLEARING MEMBERS

310. We have found nine entities (clearing members at one or more CCPs) for which the losses meet the considered criteria. In all cases, the results come from the March date, as for December the impact on CCPs and correspondingly on non-defaulting members was limited. For December there was no need to call for non-prefunded resources and, in all cases, the % consumption of default funds (including defaulters' resources) was lower than 50%.

311. For March, we have the EU-wide cover-2 results for two selection criteria, i.e. maximize shortfall and maximize overall impact. For members that were hit in both scenarios, we report here the maximum impact identified under any of the two scenarios. It is interesting to note that for the top-2 clearing members in terms of impact measured in EUR loss amount (CM1 and CM2), the respective

impact came from the “maximize overall impact” scenarios, where members’ resources are consumed by multiple CCPs at the same time. Each of the top-2 members lost resources at five CCPs simultaneously. On the contrary, the remaining members (listed in the figure above) were more severely hit under the ‘maximize shortfall’ scenario and the impact originates mostly from one CCP.

312. In all cases, the aggregate losses expressed as a percentage of capital were lower than 30%. Moreover, if one would focus on the cases that show the most severe losses, e.g. exceeding 100 million EUR, these would have impacted big institutions and would therefore correspond to lower than 15% of their capital. So, overall we see no evidence of systemic implications from second round effects to non-defaulting members via the risk-sharing mechanism of CCPs under the considered EU-wide scenarios. The main reason is that for the EU-wide scenarios we did not find many CCPs being severely hit at the same time, something that could have led to high losses to non-defaulting clearing members.
313. Finally, it should be noted that this analysis considers only the non-defaulting members that meet both aforementioned conditions. Therefore, it has not been assessed if there are clearing members with smaller losses that could however account for a large part of their capital. Moreover, the second-round effects due to bilateral relationships between clearing members are generally expected to be far more important, than any adverse effects via the loss-sharing mechanism of CCPs explored here. The bilateral relationships are however beyond the scope of this exercise. The purpose of this analysis was to explore if the risk sharing mechanism can create significant additional pressure to non-defaulting clearing members and the results of this analysis should be assessed considering that limitation.

4.3.3 Conclusions of Credit Stress Test Results

314. In the credit stress test, we analysed the sufficiency of CCPs’ resources to withstand the losses resulting from hypothetical multiple clearing member defaults combined with simultaneous extreme price changes.
315. Under the cover-2 per CCP scenario, we selected individually for each CCP two corporate groups and assumed all clearing members belonging to those groups as defaulting only in that particular CCP. For one of the two reference dates, we saw that following the default of two clearing member groups under the adverse market stress scenarios, one CCP (LME) would have to use its prefunded resources, leaving approximately 266 million EUR of residual losses. These residual losses would have to be covered with additional non-prefunded resources that the CCP had the right to call from its non-defaulting members, leaving no losses uncovered. In all other cases, the prefunded resources would be sufficient to cover the resulting losses. For the core scenarios maximising the amount of loss beyond margin, only three out of the sixteen CCPs faced under at least one of the assumed scenarios a consumption rate that was greater than 50% of prefunded resources beyond margin. Scenarios used to maximise the % consumption of prefunded resources highlighted two smaller default funds for which the scenario would cause a high % consumption accompanied with lower losses. The prefunded resources would be enough to cover the losses. We analysed the sensitivity of the results to changes of the severity of the market shocks. Assuming a 30% decrease in severity, there would be no shortfall of prefunded resources. If instead one would further increase the already extreme shocks by 20%, more CCPs would be impacted showing an increased sensitivity in some cases, without however raising any additional, systemically relevant concerns at individual CCPs.

316. For the EU-wide cover-2 scenario, we selected two clearing members groups as defaulting at an EU-wide level, i.e. the same two clearing member groups for all CCPs. The combination of defaults that led to the above highlighted shortfall would have a rather limited impact on the other CCPs, with the % consumption of prefunded resources being below 20%. When we looked for combinations of defaults that would be more impactful on an EU-wide level by hitting multiple CCPs at the same time, the results were similar. A smaller shortfall of prefunded resources for the same CCP for one of the dates and a higher consumption at other CCPs, but still in all considered scenarios a consumption of prefunded resources that was lower than 50%. Moreover, in the knock-on analysis we saw no evidence of systemic implications from second round effects to non-defaulting members via the risk-sharing mechanism of CCPs under the considered EU-wide scenarios.

4.4 Reverse Credit Stress Test Results

317. For the reverse stress tests, we perform a two-dimensional analysis of the absorption capacity of the system of CCPs by stepwise increasing the number of defaulting groups and the severity of the market shocks in order to identify at which point resources are exhausted. While exploring the different combinations, we go intentionally beyond what is considered as plausible for the purpose of this exercise. We try to capture the sensitivity of the results to the considered stress scenarios and understand how the results are affected by changing the underlying assumptions.
318. After all, although the baseline stress scenario is carefully modelled to simulate extreme market conditions, it is still subject to uncertainties and limitations, as is the case with all modelling procedures. A steep increase of the uncovered losses following a relatively small change in the shocks could indicate a high sensitivity and raise concerns on the robustness, considering the limitations and uncertainties.
319. The focus of this analysis is to identify combinations of changes in the severity of the stress test shocks and number of defaulting clearing member groups that could have systemic risk implications. Results of individual CCPs were only analysed where needed to explore the source of events that may have systemic relevance. The reverse stress analysis is limited to the credit stress test component.
320. The reverse stress test in this third EU-wide exercise has similar characteristics with the analysis performed in the previous exercise, with the addition of some enhancements.
321. With respect to the number of defaulting groups, similarly to the previous exercise, we are considering the default of the EU-wide top-n clearing member groups, where n ranges from one (1) to five (5) groups. All entities belonging to these groups are considered to be in default across all CCPs³⁴. The selection of defaulting groups for each combination of severity level and number of defaulting groups is done by an algorithm that selects the groups that maximize the losses over prefunded resources. The selection is done independently for every combination of severity level and number of defaulting groups. The selection of groups is performed without considering excess margin and is looking for the greatest loss over prefunded resources. The same selected groups are then used for the analysis of losses over non-prefunded resources and for the set of results with excess margin.
322. The different severity levels are the result of adjusting the base scenario shocks using a number of multipliers³⁵. At each severity level, the shocks of all risk factors are adjusted simultaneously. For this exercise a decrease in severity has also been included. The five severity levels are the following:
- x0.7: A decrease in the stress test shocks of 30%.
 - Base: The base scenario shocks as used for the credit stress test.
 - x1.2, x1.5, x2: An increase in the stress test shocks of 20%, 50% and 100% respectively.
323. Three tables of results are presented both using only required margin and also using excess margin:

³⁴ We have not considered the "cover-2 group per CCP" default scenarios, as omitting the cross-defaulting condition does not serve the purpose of the reverse analysis. The objective is not to assess the resilience of individual CCPs, but rather look for combinations of scenarios with significant systemic implications.

³⁵ For each value of the multiplier, the CCPs ran a full repricing of the portfolios, as opposed to applying a multiplier to the result (P&L) of the scenario

- The “Losses above Required Prefunded resources” table (Table 5) presents the aggregate (across all CCPs) amount of losses (in billion EUR) beyond prefunded resources, as applicable. These include required margin collateral, “skin-in-the-game”, default funds and other Default-Fund-level resources³⁶.
- The “Losses above Required & non-Prefunded resources” table (Table 6) presents the aggregate (across all CCPs) amount of losses (in billion EUR) beyond prefunded and non-prefunded resources (Powers of Assessment).
- The “Losses above All (including Excess) Prefunded resources” table (Table 7) presents the aggregate (across all CCPs) amount of losses (in billion EUR) beyond all prefunded resources, including Excess Margin but excluding non-prefunded Resources (Powers of Assessment).

		Loss above Required Prefunded Resources (billion EUR)					
		Market Shock					
		x0.7	Base	x1.2	x1.5	x2	
Number of Groups Defaulting	December 2018	1	-	-	0.0	0.0	0.9
		2	-	-	0.2	0.9	3.8
		3	-	0.0	0.4	2.1	6.8
		4	-	0.1	0.6	3.0	11.1
		5	-	0.2	0.8	4.2	15.3
	March 2019	1	-	-	0.2	0.5	1.0
		2	-	0.3	0.6	1.1	4.6
		3	-	0.5	1.0	1.7	9.0
		4	-	0.8	1.3	3.6	13.9
		5	0.0	1.0	1.6	5.5	19.6

37

TABLE 5: REVERSE STRESS TEST – LOSS ABOVE REQUIRED PREFUNDED RESOURCES (NO EXCESS)

324. For both dates a shortfall of prefunded resources would be experienced with an increase in any of the two parameters, i.e. increasing the number of defaulting groups from two to three or the severity of the shocks by 20%. For December, when we increase the number of defaulting groups from two to three, there is a small breach (< 50 million EUR) at one CCP, while for March we see an increase of the shortfall by approximately 0.2 billion EUR, again originating from one CCP.
325. When we move along the other dimension (increase in severity of shocks of 20%), we have already a shortfall when we assume the default of only one group. For December there is a very small shortfall at one CCP (<10 million EUR), but for March the shortfall is more significant (approximately 160 million EUR) and coming from a different CCP.
326. When we assume the default of 2 clearing member groups in combination with the more severe shocks (+20%), the shortfall increases to 0.2 billion EUR for December and 0.6 billion EUR for March. In both cases, the shortfall is calculated for the same CCP.
327. These highlighted results have already been discussed in the context of the sensitivity of the Cover-2 per CCP results in 4.3.1.4. The difference here is that we try to explore if the high sensitivity at individual CCPs could have manifested itself under the default of common participants. Here we

³⁶ The other CCP-level resources have not been considered in the reverse stress test in order to simplify the calculation, but the impact from this assumption is assessed as immaterial in the context of the reverse stress test.

³⁷ The cell is highlighted in red where there is a non-zero loss. There are cells where the loss is small (<0.1), but still greater than 0 and is thus highlighted.

assume the same participants as defaulting at the different CCPs and in the cases discussed in the previous paragraphs we see that the shortfall never comes from two CCPs at the same time. This shows that a small change in the underlying assumptions would not have hit more than one of the CCPs through common participants. However, as already commented when analysing the Cover-2 per CCP results, the increased sensitivity that we see in some cases for individual CCPs deserves further attention.

328. In the following table (Table 6) we see the shortfalls after accounting also for the non-prefunded resources that the CCPs have the right to call. Of course, one should note that each CCP uses different definitions, assumptions and conditions, when setting the maximum amounts. These may include for example specific cool-off periods, distinction between simultaneous and sequential defaults, limited scope of use for resources and different priorities amongst clearing members depending on the source of the default event. Therefore, any effort to use a harmonised modelling approach in order to analyse such a severe impact across CCPs can only serve as a rough approximation.

329. Nevertheless, it can be seen that significantly more extreme assumptions would be needed in order to create a shortfall of non-prefunded resources. Moreover, we see that in some cases the shortfall is decreased despite making the assumptions more extreme. This is because the selection is always done using the required margin without considering non-prefunded resources or excess margin³⁸.

		Loss above Required & Non-Prefunded Resources (billion EUR)					
		Market Shock					
		x0.7	Base	x1.2	x1.5	x2	
Number of Groups Defaulting	December 2018	1	-	-	-	-	-
		2	-	-	-	-	-
		3	-	-	-	-	0.3
		4	-	-	-	-	-
		5	-	-	-	-	0.1
	March 2019	1	-	-	-	0.1	0.6
		2	-	-	-	0.4	0.5
		3	-	-	-	0.6	1.0
		4	-	-	0.3	-	1.5
		5	-	0.0	0.7	0.6	2.9

TABLE 6: REVERSE STRESS TEST – LOSS ABOVE REQUIRED & NON-PREFUNDED RESOURCES (NO EXCESS)

330. In the following table (Table 7) we present the results if one would use not only the Required but also the Excess Margin. This analysis is only using prefunded resources excluding Powers of Assessment. We see that in terms of the “breaking point”, i.e. at which point the resources are exhausted, the results are similar to what we observed when only using the required margin (Table 5). We see in some cases smaller shortfalls, especially for the most extreme assumptions, but it seems that the excess margin would not have any drastic mitigating effect for small changes in the underlying assumptions.

³⁸ For example, by increasing the number of defaults the CCP could have access to more non-prefunded resources, which in many cases are set in relation to the number of defaults. Moreover, it can be that the pair of members that would maximise the “Required Shortfall” would have more excess margin or give access to more non-prefunded resources and thus limit the shortfall after considering those.

		Loss above All (including Excess) Prefunded Resources (billion EUR)					
		Market Shock					
		x0.7	Base	x1.2	x1.5	x2	
Number of Groups Defaulting	December 2018	1	-	-	0.0	0.0	0.4
		2	-	-	0.2	-	2.5
		3	-	0.0	0.4	1.0	5.4
		4	-	0.1	0.6	1.8	4.8
		5	-	0.2	0.7	2.9	7.9
	March 2019	1	-	-	0.1	0.4	1.0
		2	-	0.2	0.6	1.1	2.2
		3	-	0.5	0.9	1.6	5.9
		4	-	0.7	1.2	1.0	10.5
		5	-	0.9	1.5	1.6	15.6

TABLE 7: REVERSE STRESS TEST – LOSS ABOVE ALL (INCLUDING EXCESS) PREFUNDED RESOURCES

331. From the analysis of the main results (only required margin and prefunded resources, i.e. Table 5) we can see two more general behaviours that are worth noting:

- a. When market shocks are reduced by 30%, the increase in defaulting groups has a very limited effect.
- b. Taking as a starting point the base scenario and two defaulting groups, incremental changes in market shocks severity are more harmful than increases in the number of defaulting groups.

332. With respect to the first behaviour, we can infer that with a 30% reduction in stress test shocks a great deal of the losses would be absorbed by the initial margin model. This would make the impact to the default fund so limited that the cumulative losses from increasing the number of defaulting groups would not pose significant risk to the CCP. According to our results, only with five simultaneous defaulting groups we would be able to see a small breach of prefunded resources.

333. With respect to the difference in the effect of the incremental changes of the two factors that drive the reverse stress test, we can see how the independent step-wise increment of each of the parameters taking as a reference the base case (two defaulting groups, base scenario shocks) behaves in the following graph:

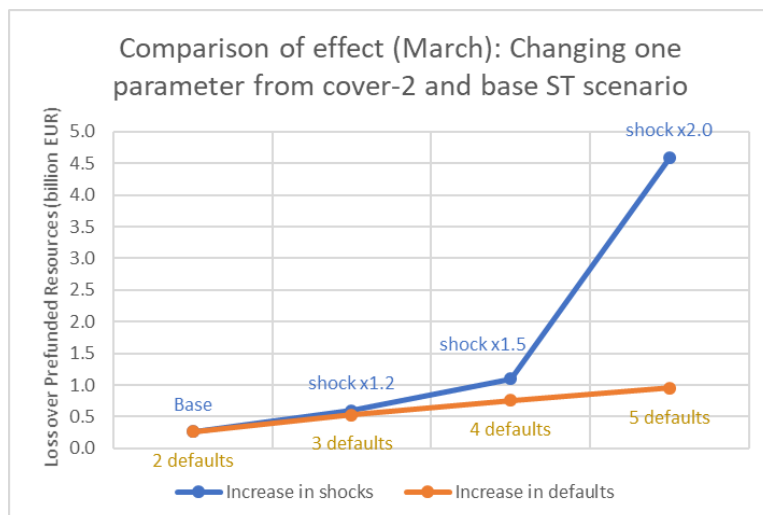


FIGURE 31: COMPARING THE IMPACT FROM INCREASING SHOCKS OR DEFAULTS

334. We can draw some general conclusions about the behaviour of changes to the two parameters in the reverse stress test results. The results from increases in the number of group defaults exhibit a behaviour that is closer to linear, for every level of market shock severity, once the prefunded resources have been exhausted. By increasing the number of defaults, we assume the default of entities whose impact is, by definition, smaller than the entities already assumed to be in default. On the other hand, at the same time, the increase of the number of defaults leads to breaches at additional CCPs that can inflate the rate of increase for the aggregate impact³⁹. The marginal increase from every defaulting group seems to follow a relationship that is closer to linear, compared to what we get for the marginal increase from changing the shocks. This can be better observed in the following graph (Figure 32) covering the effect of changes in defaulting groups for all shock severities:

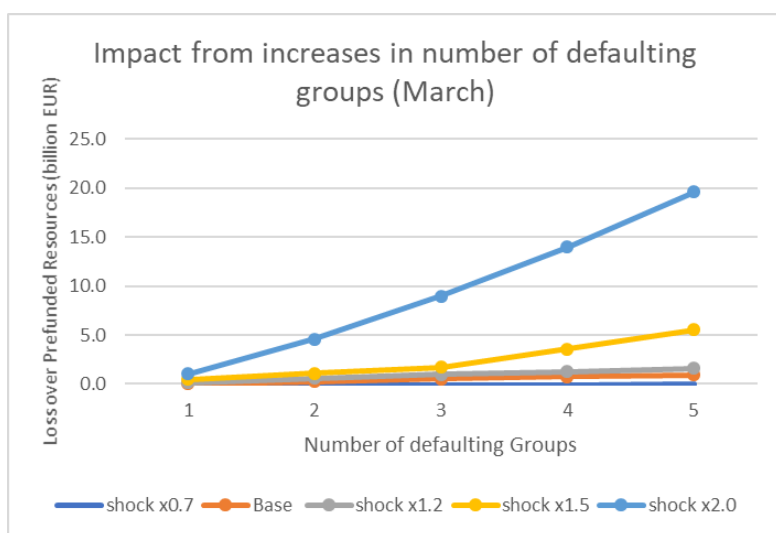


FIGURE 32: IMPACT FROM INCREASING NUMBER OF DEFAULTS

335. In contrast to the behaviour of the increases in number of defaulting groups, the changes in severity of the shocks produce a more severe impact as the distance to the base scenario increases (in axis, the base scenario is 1.0). This can be observed in the following graph (Figure 33) covering the effect of changes in shock severity for all different numbers of defaulting groups:

³⁹ This is shown for example as a change in the rate of increase from 2 to 4 defaulting groups, for the x1.5 shock curve.

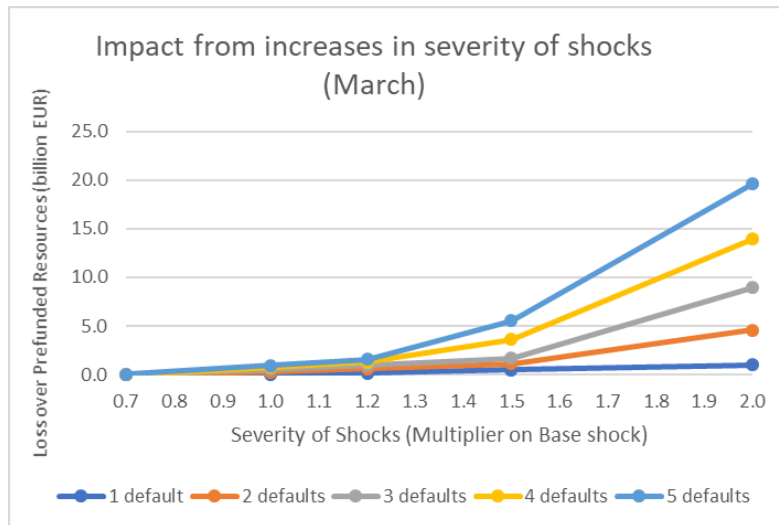


FIGURE 33: IMPACT FROM INCREASING SEVERITY OF SHOCKS

336. One of the key limitations of this analysis is that second round effects are increasingly relevant as scenarios become more extreme, beyond what can be reasonably considered as plausible. However, as in the core credit stress test, second round effects are not accounted for. It should be highlighted that in practice the wide-spread effects from such catastrophic events in the financial system cannot be analysed fully only considering the CCPs and the cleared exposures. Therefore, due to its limited scope, this analysis cannot predict the impact from such events. Its purpose is to assess the sensitivity of the CCP stress results to small changes in the scenarios and underlying assumptions.

4.5 Concentration Stress Test Results

337. This section presents the concentration stress test results computed following the methodology detailed in Section 3.5. As a reminder, the objective of this analysis is to assess the adequacy of CCPs' resources in covering the cost of liquidating concentrated positions. To do so the exercise computed the market impact of liquidating concentrated positions in different asset classes on the basis of estimates provided by CCPs.

338. The common sensitivity parameters are first presented for each asset class. To increase transparency, the market impact on typical concentrated positions is provided. The concentration risk is then analysed at EU-wide and CCP level. The market impact is compared against corresponding concentration add-ons as well as total required margins. The accuracy of the coverage of market impact risk at clearing member level is also investigated. Finally, the potential impact of concentrated positions on mutualised resources is analysed.

4.5.1 Sensitivity parameters

339. Based on the data reported by CCPs, and in accordance with the methodology described in section 3.5, EU-wide sensitivity tables have been built for each sub-asset class.

340. A selection of the most important EU-wide sensitivity parameters is reported below.

341. For each asset class, the Figures below show how the market impact rises when increasing the position size (in bps).

342. We also provide worked out examples (Table 8 to Table 19) of the market impact for representative large positions in each asset class. This ensures transparency on the parameters and inputs used, which are based on the CCPs' inputs.

Bonds

343. Bonds sensitivity estimates are provided by type of issuer (Corporate/Sovereign) and maturity. Figure 34 and Table 8 show that, based on data reported by CCPs, for similar positions the market impact for bonds is generally higher for corporate than for sovereign bonds and tends to grow faster with position size for longer maturities.

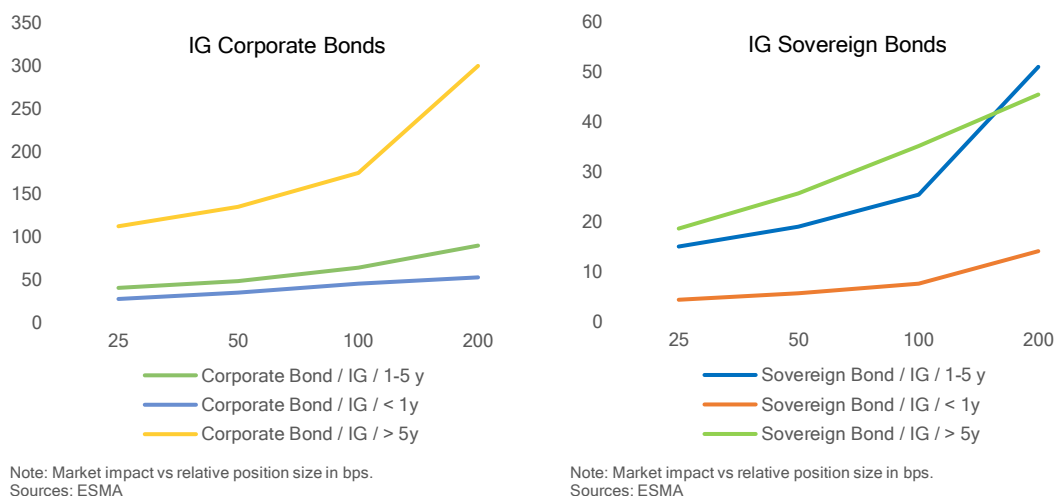


FIGURE 34: MARKET IMPACT VS. RELATIVE POSITION SIZE, IG CORPORATE AND SOVEREIGN BONDS

TABLE 8: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, IG BONDS

Investment Grade Bonds						
Sub-asset Class	Maturity	Position Value (k€)	Reference Volume (k€)	Significant Position Size	Market Impact (bps)	Market Impact (k€)
Sovereign Bond	1 to 5 years	-273,966	169,556	1.62	41	1,129
Corporate Bond	1 to 5 years	15,505	2,009	7.72	90	140
Corporate Bond	< 1 year	7,333	7,169	1.02	46	33
Sovereign Bond	> 5 years	-1,636,295	1,000,000	1.64	42	6,831

Equities

344. Equities sensitivity estimates are differentiated by capitalization size (Small/Mid/Big cap). Overall, Figure 35 shows a similar evolution of the market impact with size across all equities instruments (although for no clear reason, according to the data reported by CCPs market impact for Mid Cap tends to grow faster with size).

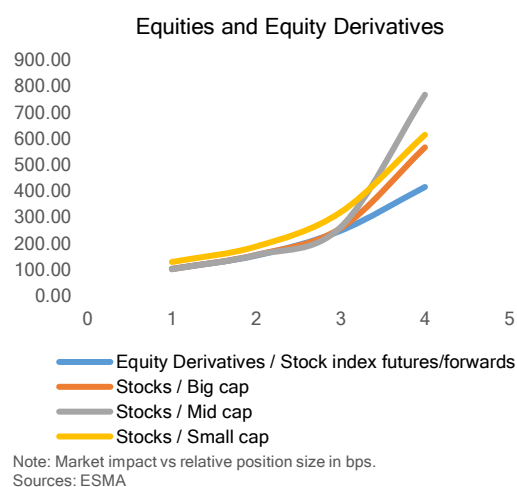


FIGURE 35: MARKET IMPACT VS. RELATIVE POSITION SIZE, EQUITIES AND EQUITY DERIVATIVES

TABLE 9: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, SN EQUITY DERIVATIVES AND SECURITIES

Single Name Equity Derivatives and Securities						
Sub-asset Class	Position Value (k€)	Reference Volume (k€)	Position Size	Market Impact (bps)	Market Impact (k€)	
Small cap	365	76	4.82	614	22	
Small cap	-1,622	2,719	0.60	214	35	
Mid cap	4,810	4,068	1.18	354	170	
Mid cap	8,218	4,068	2.02	767	630	
Big cap	-243	160	1.52	418	10	
Big cap	374,917	524,609	0.71	200	7,500	

TABLE 10: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, OTHER EQUITY DERIVATIVES

Other Equity Derivatives						
Sub-asset Class	Position Value (k€)	Reference Volume (k€)	Significant Position Size	Market Impact (bps)	Market Impact (k€)	
ETF futures/forwards	1,174	902	1.30	299	35	
Stock index futures/forwards	14,923	2,938	5.08	415	620	
Stock index futures/forwards	-1,688,538	6,203,024	0.27	108	18,215	
Stock index futures/forwards	1,519,319	295,266	5.15	415	63,098	

Energy and other commodity derivatives

345. Figure 36 shows that for comparable positions median sensitivities for electricity and freight derivatives are more aggressive than for other commodities. Overall for most commodities the sensitivity growths almost linearly with the size of the position.

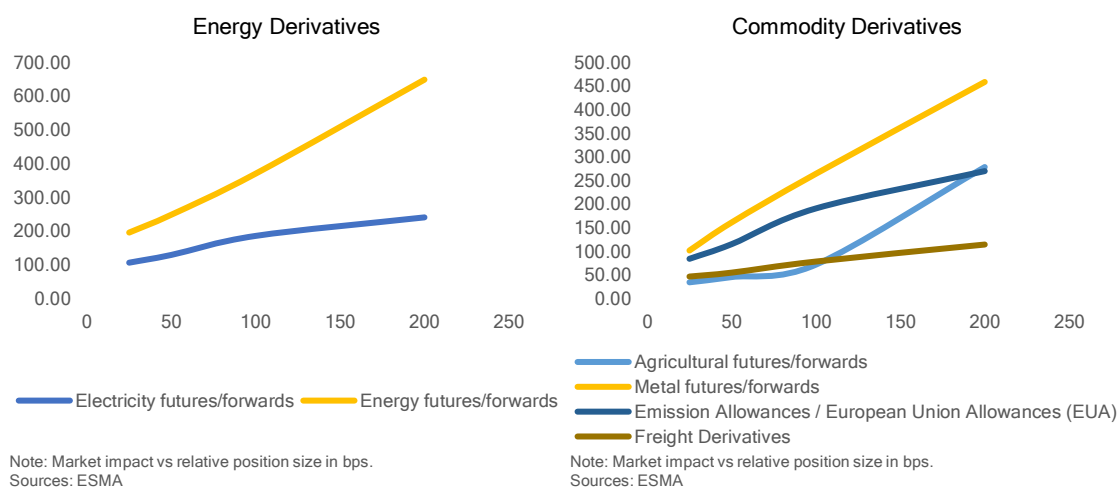


FIGURE 36: MARKET IMPACT VS. RELATIVE POSITION SIZE, ENERGY AND COMMODITY DERIVATIVES

TABLE 11: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, METAL COMMODITY FUTURES/FORWARDS

Commodity Derivatives - Metal commodity futures/ forwards								
Metal	Maturity	Position Value (k\$)	Reference Volume (k\$)	Position Size	Market Impact (bps)	Market Impact (k\$)	Market Impact (k€)	
NICK	2Y-3Y	9,700	17,366	0.56	173	168	150	
CBLT	0-1Y	3,309	1,758	1.88	436	144	129	
TINN	1Y-2Y	1,297	464	2.80	459	60	53	
GOLD	0-3M	482,731	298,955	1.61	384	18,534	16,516	
SLVR	0-3M	-70,500	32,350	2.18	459	3,235	2,883	

TABLE 12: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, ENERGY COMMODITY FUTURES/FORWARDS

Energy commodity futures/forwards								
Sub-asset Class	Segment			Position Value (k€)	Reference Volume (k€)	Position Size	Market Impact (bps)	Market Impact (k€)
electricity	BSLD	baseload	1Y-2Y	-25,860	5,306	4.87	241	623
natural gas	NCGG	baseload	0-1M	-62,801	26,749	2.35	649	4,077
coal	COAL		1Y-2Y	274,725	109,872	2.50	649	17,835
oil	KERO		0-4M	1,040,348	182,798	5.69	649	67,541
oil	BRNT		1Y-2Y	-5,322,787	3,610,508	1.47	503	267,595

Note: the delivery point is a segmentation criterium for electricity derivatives.

TABLE 13: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, AGRICULTURAL COMMODITY FUTURES/FORWARDS

Agricultural commodity futures/forwards						
Underlying	Maturity	Position Value (k€)	Reference Volume (k€)	Significant Position Size	Market Impact (bps)	Market Impact (k€)
DIRY	0-3M	7,639	499	15.31	279	213
CCOA	1Y-2Y	-248,634	72,305	3.44	279	6,928
CORN	0-3M	20,116	12,672	1.59	193	389
SEAF	0-3M	514	45	11.31	279	14

TABLE 14: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, FREIGHT DERIVATIVES

Freight Derivatives								
Segment	Segment	Segment	Maturity	Position Value (k€)	Reference Volume (k€)	Significant Position Size	Market Impact (bps)	Market Impact (k€)
Dry bulk	Capesize	CPT	6M-9M	2,753	124	22.23	115	32
Dry bulk	Handysize	HTC	1Y-2Y	-2,294	92	25.00	115	26
Dry bulk	Panamax	PTC	2Y-3Y	3,223	179	18.04	115	37
Tanker	270,000mt	ME Gulf to China	1Y-2Y	-48,589	960	50.62	115	556
Tanker	55,000mt	ME to Japan	1Y-2Y	6,791	176	38.61	115	78
Tanker	130,000mt	W Africa to Cont	9M-1Y	2,366	84	28.05	115	27

Note: freight positions are typically very large compared to the average daily notional amounts.

TABLE 15: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, EUA

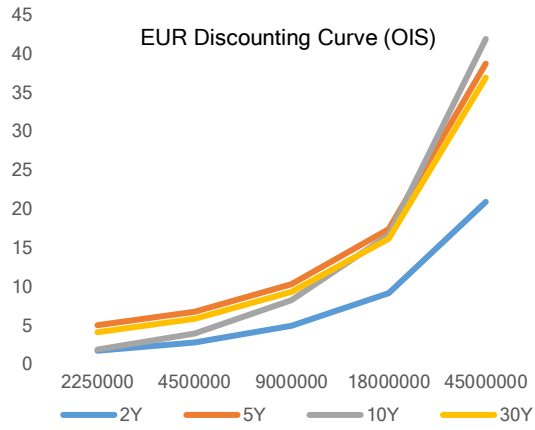
Emission Allowances - European Union Allowances (EUA)						
Maturity	Position Value (k€)	Reference Volume (k€)	Significant Position Size	Market Impact (bps)	Market Impact (k€)	
0-4M	1,474,747	560,255	2.63	270	39,818	
1Y-2Y	-962,602	169,941	5.66	270	25,990	
5Y-6Y	1,934	434	4.45	270	52	
2Y-3Y	-206,842	60,806	3.40	270	5,585	

Fixed Income Derivatives

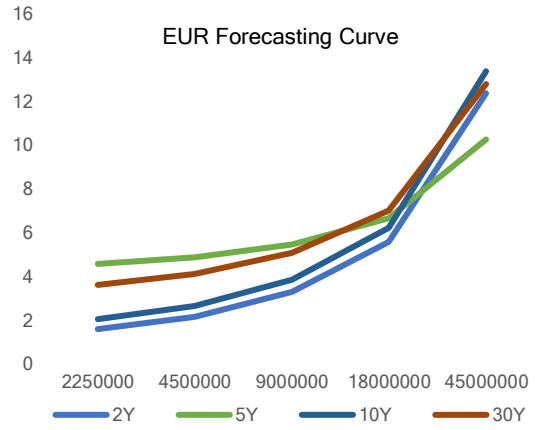
346. For each currency, curve type (Discounting, Forecasting, OIS vs IBOR) and maturity point (2Y, 5Y, 10Y, 30Y), the highest submitted PV01 reference notional was chosen to ensure the best possible coverage across clearing members concentrated positions.

347. A linear fit was used to generate the common sensitivity table for each currency. Figure 37 shows a similar behaviour for all maturity points of the curve, with very steep increases (almost exponential)

for large position sizes



Note: Hedging market impact vs position size in bps.
Sources: ESMA



Note: Hedging market impact vs position size in bps.
Sources: ESMA

FIGURE 37: MARKET IMPACT VS. RELATIVE POSITION SIZE, EUR FIXED INCOME DERIVATIVES

348. The following tables show worked out examples of market impact computation for typical representative fixed income derivatives positions.

TABLE 16: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, EUR FIXED INCOME DERIVATIVES

EUR - Fixed Income Derivatives						
Curve Type	Maturity	Hedge PV01	Hedge Size	Market Impact (bps)	Market Impact Pnl EUR	
Discounting	2Y	14,867,682	1.65	7.66	113,934,616	
Discounting	5Y	12,635,326	1.40	13.19	166,691,367	
Discounting	10Y	-	5.44	41.87	2,048,138,415	
Discounting	30Y	-	4.31	32.13	1,246,800,986	
Forecasting	2Y	12,133,383	1.35	4.09	49,579,925	
Forecasting	5Y	11,702,908	1.30	5.83	68,251,355	
Forecasting	10Y	19,667,242	2.19	6.67	131,114,136	
Forecasting	30Y	21,642,729	2.40	7.80	168,806,370	

TABLE 17: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, GBP FIXED INCOME DERIVATIVES

GBP - Fixed Income Derivatives						
Curve Type	Maturity	Hedge PV01	Hedge Size	Market Impact (bps)	Market Impact Pnl GBP	
Discounting	2Y	12,390,209	4.13	7.53	93,261,384	
Discounting	5Y	6,413,303	1.80	6.93	44,429,692	
Discounting	10Y	2,316,468	0.65	4.00	9,272,190	
Discounting	30Y	-	1.27	9.22	41,833,971	
Forecasting	2Y	4,675,542	1.56	6.53	30,516,726	
Forecasting	5Y	1,644,560	0.46	8.65	14,228,734	
Forecasting	10Y	5,338,152	1.50	6.02	32,159,407	
Forecasting	30Y	5,959,164	1.67	10.53	62,754,425	

TABLE 18: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, USD FIXED INCOME DERIVATIVES

USD - Fixed Income Derivatives						
Curve Type	Maturity	Hedge PV01	Hedge Size	Market Impact (bps)	Market Impact Pnl USD	
Discounting	2Y	-	3.31	17.89	355,004,761	
Discounting	5Y	15,644,629	2.61	10.16	158,912,924	
Discounting	10Y	21,720,665	3.62	11.68	253,731,427	
Discounting	30Y	18,351,630	3.06	11.52	211,379,278	
Forecasting	2Y	-	3.00	16.14	290,026,639	
Forecasting	5Y	20,440,234	3.41	11.97	244,759,429	
Forecasting	10Y	-	4.37	13.16	345,337,370	
Forecasting	30Y	-	2.62	8.37	131,433,278	

Credit Derivatives

349. The concentration risk for credit derivatives is assessed through the market impact cost of setting-up a relevant hedging portfolio. Such hedging is assumed to be done using the 5Y maturity only.

350. CCPs reported identical hedging cost parameters for off-the-run and on-the-run series.

351. Overall, Figure 38 shows that the sensitivity grows in a similar way with position size for all sub-asset classes considered. As expected, the market impact is somehow higher when the credit quality of the underlying decreases (e.g. market impact for CDX HY is higher than for CDX IG Main).

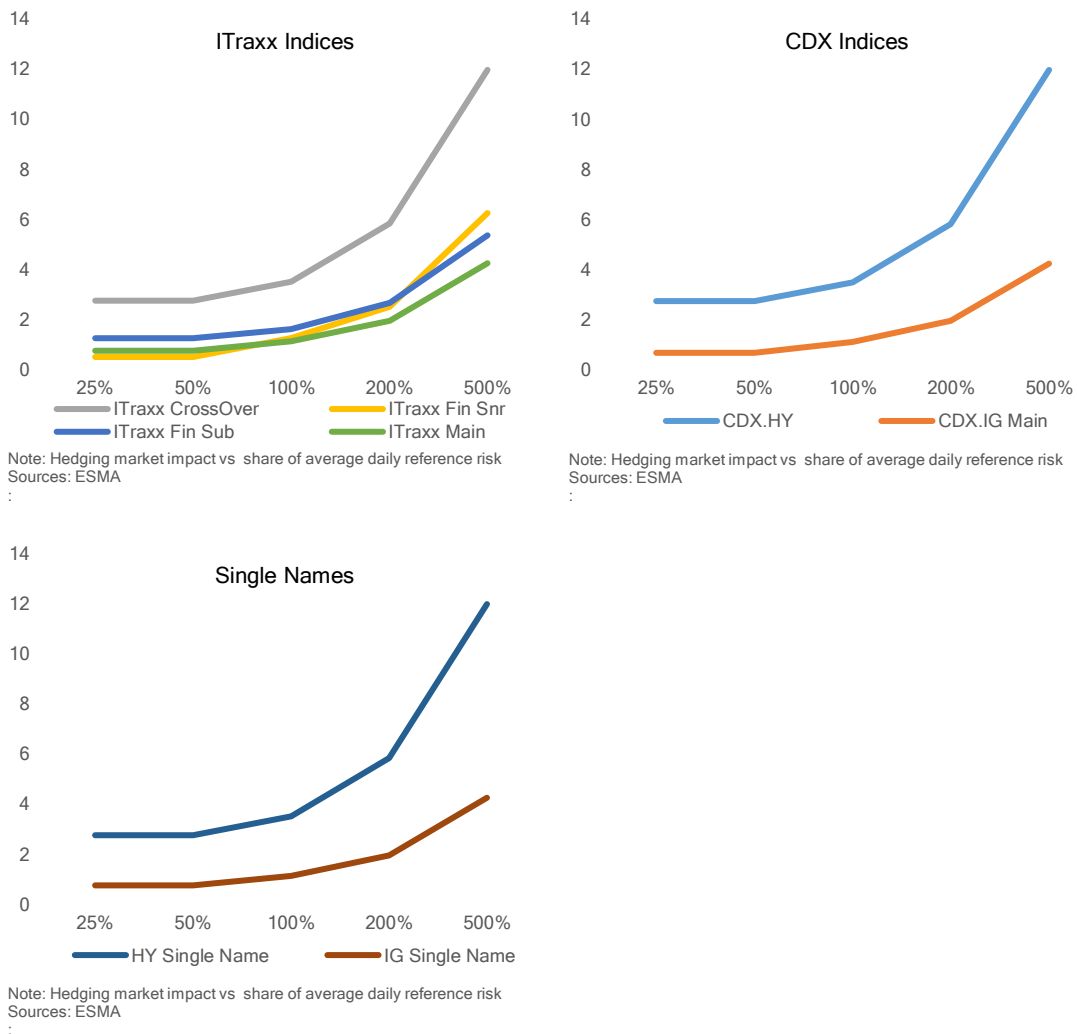


FIGURE 38: MARKET IMPACT VS. RELATIVE POSITION SIZE, CREDIT DERIVATIVES

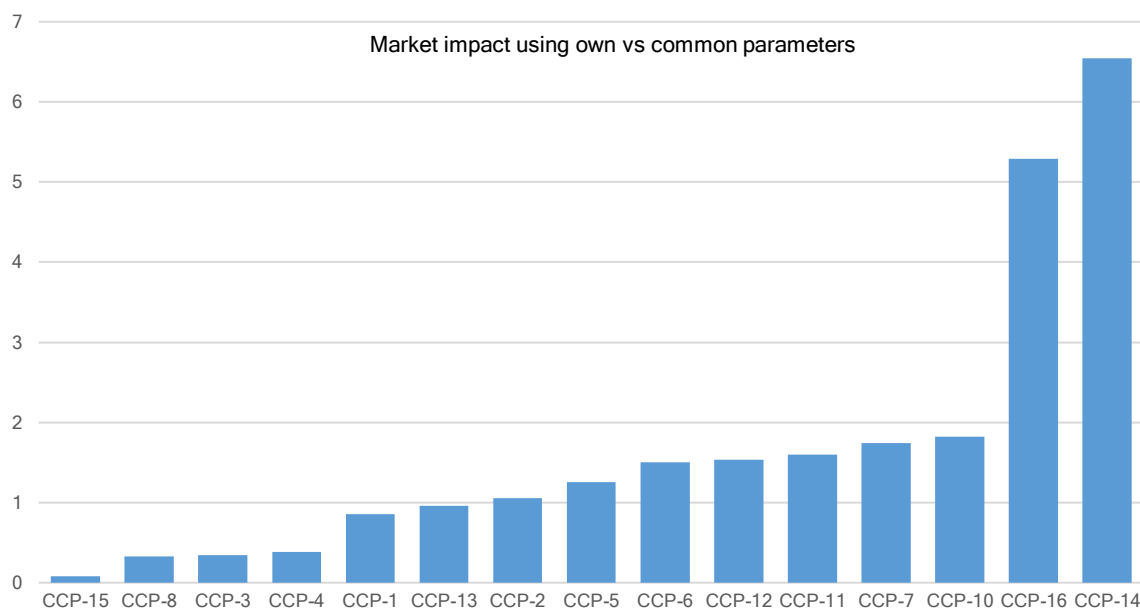
TABLE 19: MARKET IMPACT ON REPRESENTATIVE LARGE POSITIONS, CREDIT DERIVATIVES

		Credit Derivatives				
Curve Type		Average Daily Risk Per Basis Point	Position Risk Per Basis Point	Relative Hedge Size	Market Impact (bps)	Market Impact Pnl
USD	CDX.HY off-the-run	211,522	-60,287	-0.29	2.75	165,791
USD	CDX.HY on-the-run	705,073	-219,219	-0.31	2.75	602,853
USD	CDX.IG Main on-the-run	3,960,162	1,298,825	0.33	0.69	892,942
EUR	CrossOver off-the-run	320,819	148,539	0.46	2.75	408,483
EUR	CrossOver on-the-run	232,215	82,784	0.36	2.75	227,657
EUR	Fin Snr off-the-run	282,860	134,567	0.48	0.50	67,283
EUR	Fin Snr on-the-run	565,720	-211,768	-0.37	0.50	105,884
EUR	Fin Sub off-the-run	81,200	-33,610	-0.41	1.25	42,012
EUR	Fin Sub on-the-run	139,199	38,271	0.27	1.25	47,838
EUR	HY Single Name	14,507	4,694	0.32	2.75	12,909
EUR	IG Single Name	11,581	-15,923	-1.37	1.44	22,868
EUR	ITraxxMain off-the-run	1,184,671	-746,593	-0.63	0.85	632,855
EUR	ITraxxMain on-the-run	3,317,079	2,059,503	0.62	0.84	1,731,340

4.5.1.1 Impact of using common parameters

352. In some markets, some CCPs have a dominant share of clearing while others clear a far smaller share. All those CCPs contributed equally to the EU-wide sensitivity table through their submissions.
353. To assess whether such discrepancies lead to overly conservative sensitivities, market impacts were also computed using the CCPs own parameters.
354. 9 of 15 CCPs' market impacts would be higher using their own parameters submissions⁴⁰ (as illustrated in Figure 39). In other words, the choice of common parameters is more lenient for those 9 CCPs as it reduces the overall market impact, and more conservative for the others.

⁴⁰ Note that this does not necessarily imply that such CCPs have a better coverage of concentration risk, as the comparison is only referring to the parameters submitted by CCPs for the purpose of this stress test exercise, which are not necessarily the ones used internally to account for this risk.



Note: Ratio of market impact using own parameters by market impact using common parameters.
Sources: ESMA

FIGURE 39: COMPARISON OF MARKET IMPACT USING OWN VS COMMON PARAMETERS

4.5.1.2 Position overlap analysis

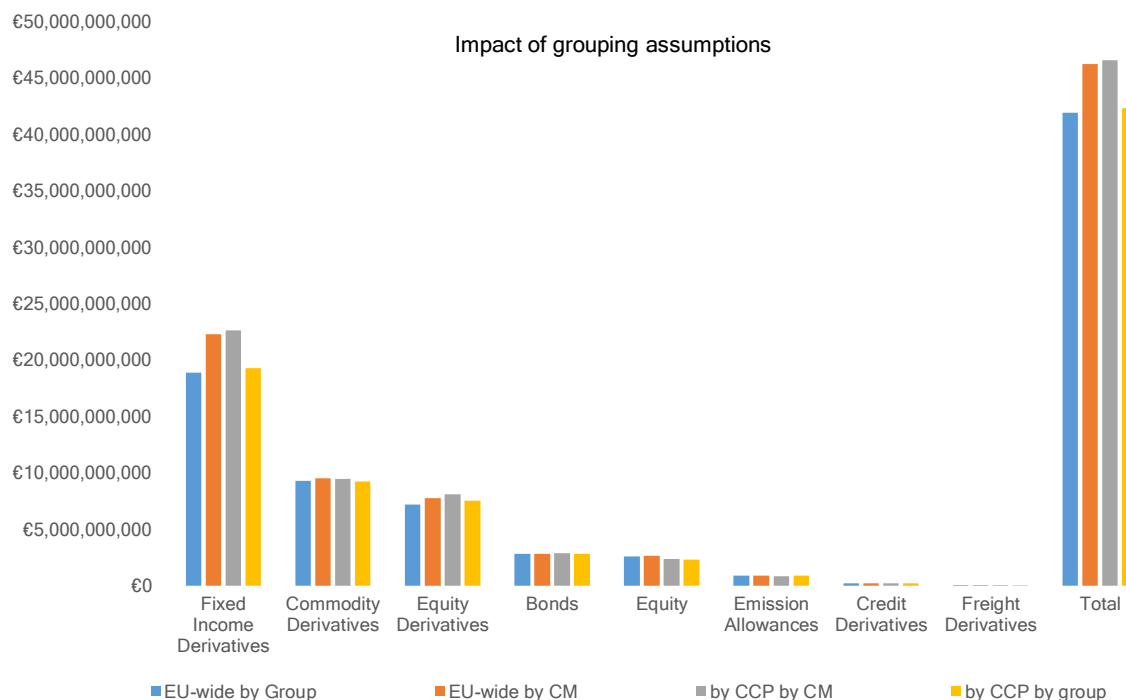
355. Under a real-life default scenario, we would assume that the liquidation of defaulting clearing members' positions would happen at the same time in all CCPs. When multiple CCPs liquidate the positions of a clearing member (or a clearing member group) simultaneously, we need to consider the total net position for each aggregation level.

356. The total net position is used to determine the market impact in bps. Therefore, offsetting (resp. same direction) positions will reduce (resp. increase) the cost of liquidating each of the position.

357. In order to assess the impact of aggregating positions across clearing member groups and CCPs, the total market impact can be computed in 4 different ways:

- Each CM independently in each CCP;
- Each CM simultaneously in all CCPs;
- Each group independently in each CCP;
- Each group simultaneously in all CCPs.

358. As illustrated in Figure 40, we find little overlap in positions between CCPs.



Note: Total market impact under different assumptions : 1) EU-wide or by CCP in turn and 2) by clearing member group or by clearing member in turn.
Sources: ESMA

FIGURE 40: EFFECT OF GROUPING POSITIONS ON THE CALCULATED MARKET IMPACT

359. The biggest offsets appear to be between clearing members of the same group in fixed income derivatives.
360. As the above assumptions have no significant impact, and in order to simplify the reconciliation of results, market impacts have been reported assuming a liquidation at the CCP level only in the rest of the exercise.

4.5.2 EU-wide impact

4.5.2.1 EU-wide market impact per asset class

361. The sum of the market impacts of all clearing members does not represent the actual concentration risk faced by the CCPs, as CMs would not all default simultaneously, and because the final impact may be lowered by offsetting positions between defaulting CMs.
362. However, the aggregated market impact approximates what would need to be charged by CCPS to cover the concentration risk, generally through dedicated add-ons (or other duly computed resources included in the initial margin).
363. Figure 41 shows the aggregated EU-wide market impact for each asset class, across all CCPs of the exercise.
364. The results show that fixed income derivatives is the asset class with the largest concentrated positions with over 19bn EUR of concentration risk.

365. Concentration in commodity derivatives and in the equity segment (securities and derivatives) is very significant as well, with around 9.5bn EUR of concentration risk.
366. As some spread positions were not decomposed in their underlying contracts and the delivery location was not always used in the submitted templates, the actual concentration risk for commodities may be underestimated.
367. The low market impact for credit derivatives is most likely driven by methodological limitations⁴¹ of the framework.

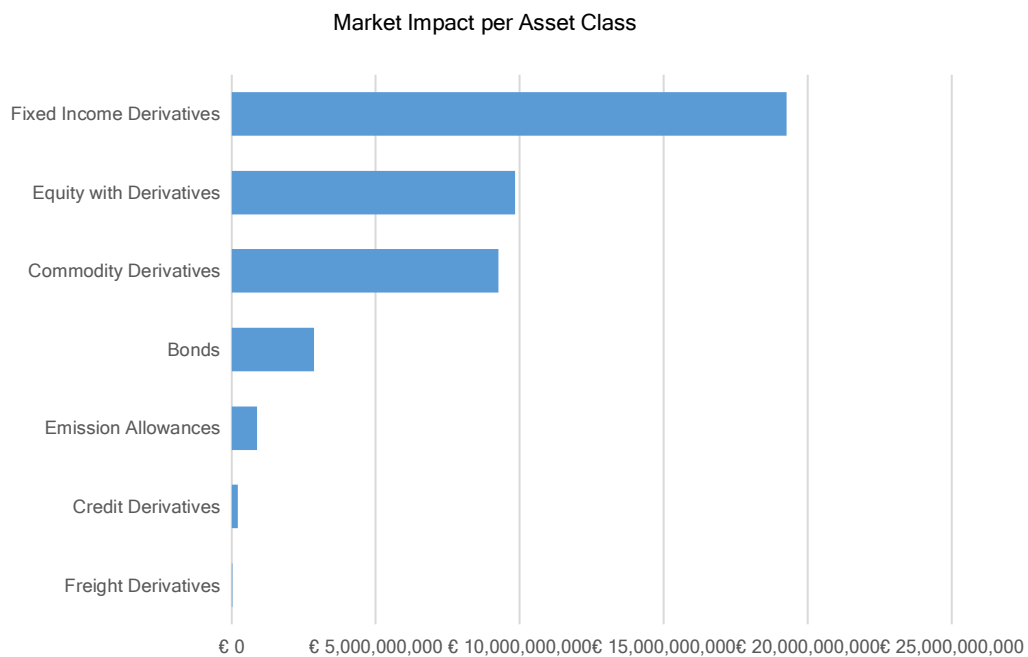


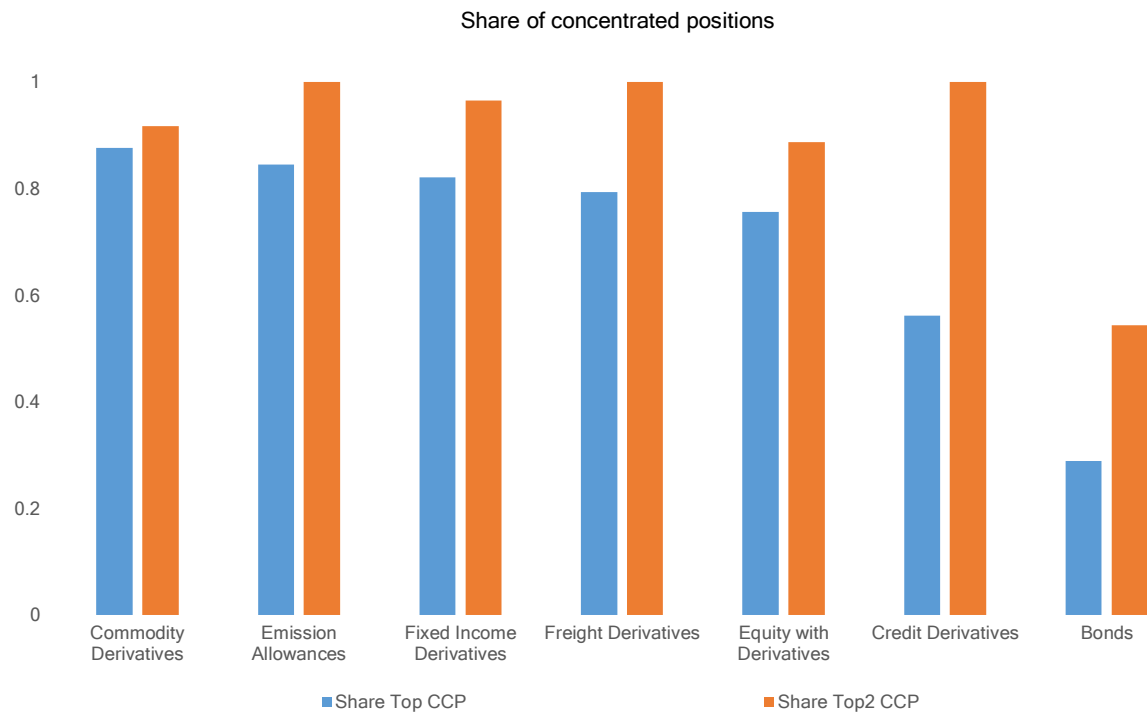
FIGURE 41: EU-WIDE MARKET IMPACT PER ASSET CLASS

368. However, not all CCPs exhibit concentrated positions. Figure 42 shows the share of the biggest and Top 2 CCPs relative to the total EU-wide market impact.
369. As illustrated, for most asset classes concentrated positions are clustered in only a few CCPs. Only concentrated positions in bonds are spread over many CCPs.

⁴¹ For credit derivatives, the market impact is the cost of hedging using the 5Y maturity only, with the following consequences:

- 1) Calendar spread positions on the curve are netted and therefore have their cost much reduced.
- 2) The difference in liquidity between different maturities is ignored, and the most liquid point is used.
- 3) For single names, different restructuring conventions are ignored.

For both CCPs clearing CDSs, the market impact is much lower than the add-ons they charge.

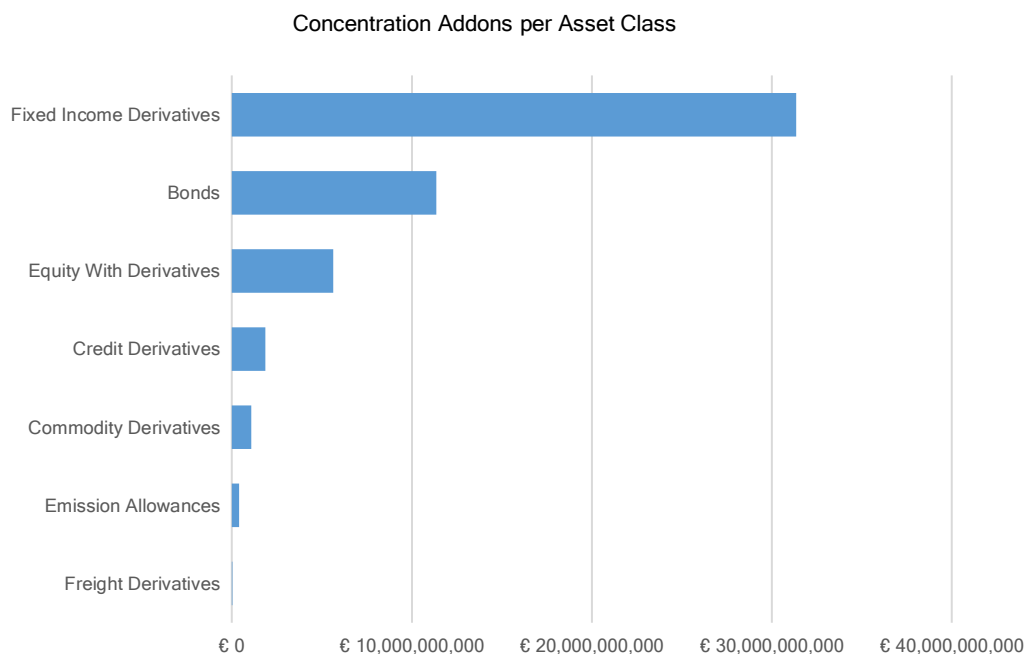


Note: Share of the EU-wide market Impact of the CCPs with the largest concentrated positions
 Some asset classes (Emission Allowances, Freight Derivatives and Credit Derivatives) are only cleared by 2 CCPs.
 Sources:ESMA

FIGURE 42: SHARE OF CONCENTRATED POSITIONS AMONG THE TOP 1 & 2 CCPS, PER ASSET CLASS

4.5.2.2 Comparison of concentration add-ons and market impact

370. CCPs generally charge concentration add-ons to cover concentration risk. Such add-ons are reported in Figure 43, aggregated on an EU-wide basis, by asset classes. The analysis shows that such add-ons are skewed towards fixed income derivatives, bonds and equity derivatives.



Note: EU-wide total concentration addons
Sources: ESMA

FIGURE 43: EU-WIDE REPORTED CONCENTRATION ADD-ONS, PER ASSET CLASS

371. In the following Figures, concentration add-ons as reported by CCPs have been compared to the computed market impact. Results show that concentration add-ons do not cover the market impact in 3 main asset classes:

- Commodity derivatives (Figure 44): add-ons are far lower than the market impact, covering around 11.7% of the risk and with a gap of around 8 bn EUR;
- Equity (with derivatives): add-ons cover 57% of the risk with a gap of around 4.2 bn EUR;
- Emission allowances: half of the risk is covered with a gap of 465 million EUR.

372. Add-ons for fixed income derivatives exceed significantly the framework market impact. However, it should be noted that the framework only models a first order hedge and does not factor in further auction costs.

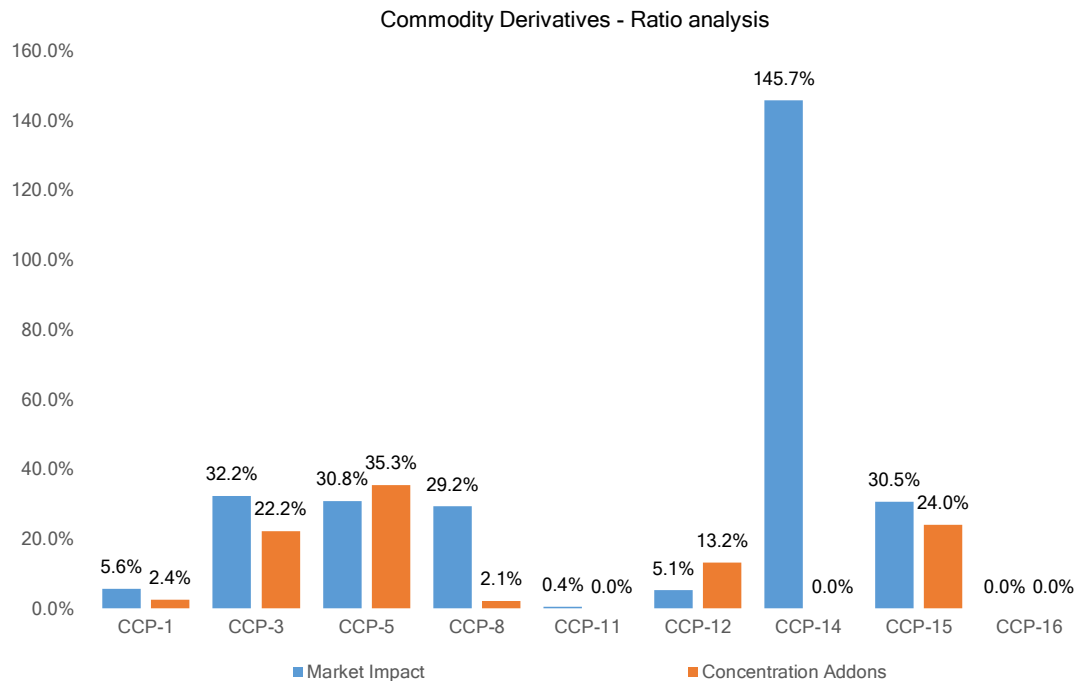
373. Add-ons for bonds largely exceed the computed market impact at the EU-wide level.

374. Within asset classes, the coverage of market impact risk with concentration add-ons differs across CCPs. By normalising the market impact and the add-ons by the total required margin, we can visualize both the importance of concentration and the different treatment by the CCPs. Even for CCPs that did not report dedicated concentration add-ons, this also makes it possible to assess how much of the total required margin is required to cover concentration risk alone.

375. For example, for commodity derivatives, for some CCPs, add-ons exceed the market impact, but for some other add-ons do not cover it. The market impact would also use a very large part of the required margin the CCPs currently charge in some cases. Keeping in mind the limitations of the exercise, this could probably indicate an insufficient coverage of concentration risk.

376. The results for CCP-14 only cover a small default fund for which the concentration risk exceeds the

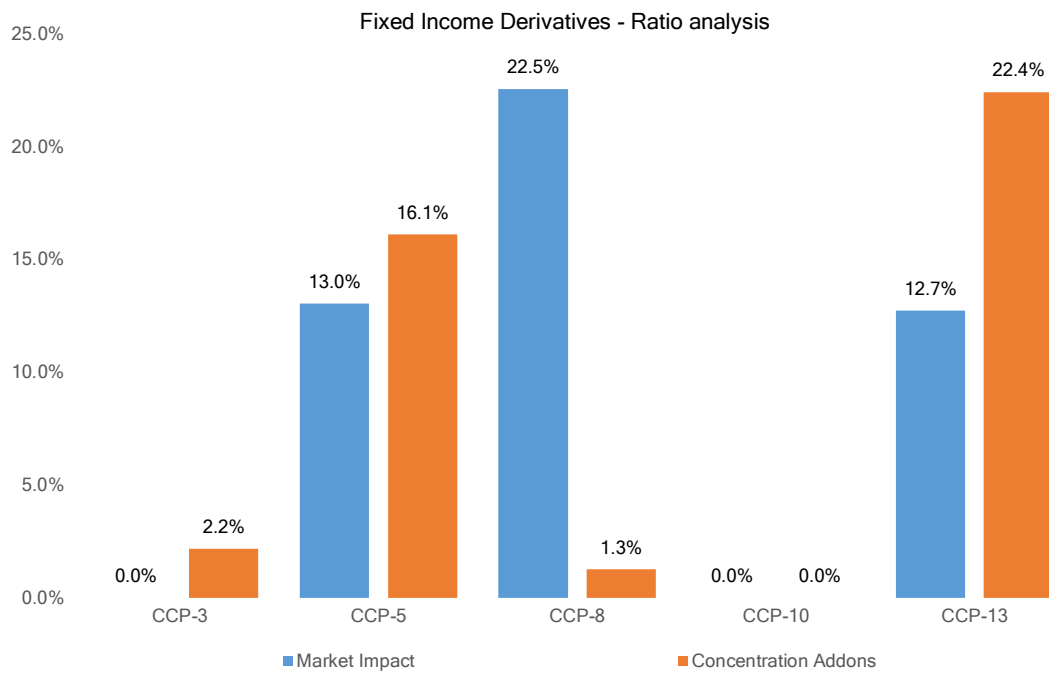
total required margin. For this CCP, other commodity positions are not reported in Figure 44 as their corresponding add-ons cover also for concentration risk of another asset class.



Note: Market Impact and Concentration addons normalized by required margin.
Sources: ESMA

FIGURE 44: COMPARISON OF MARKET IMPACT AND CONCENTRATION ADD-ONS, COMMODITY DERIVATIVES

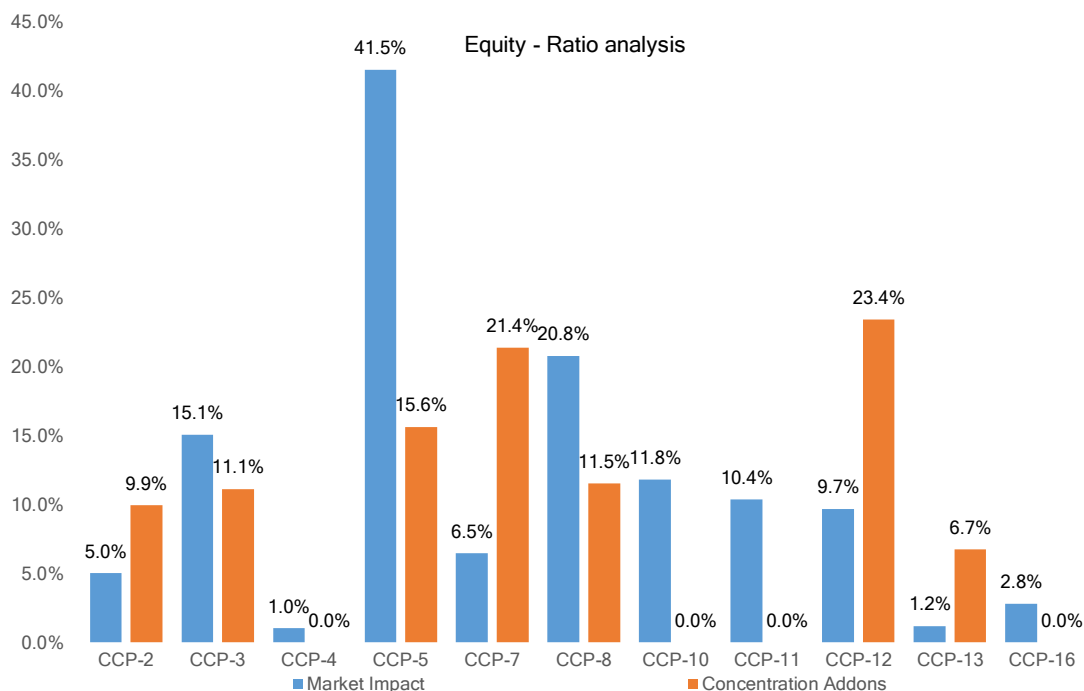
377. For fixed income derivatives, the add-ons and market impacts are more in line. For one CCP, add-ons do not cover the market impact with a gap of around 20% of the required margin.



Note: Market Impact and Concentration addons normalized by required margin.
Sources: ESMA

FIGURE 45: COMPARISON OF MARKET IMPACT AND CONCENTRATION ADD-ONS, FIXED INCOME DERIVATIVES

378. For equity and equity derivatives, concentration risk and add-ons seem overall to be balanced. However, a CCP has a significant gap of 26% of required margin between its concentration risk and corresponding add-ons. For that CCP, the framework market impact represents 42% of the required margin.



Note: Market Impact and Concentration add-ons normalized by required margin. Includes both Equity and Equity Derivatives.
Sources: ESMA

FIGURE 46: COMPARISON OF MARKET IMPACT AND CONCENTRATION ADD-ONS, EQUITY

379. Although all CCPs have market impact risk according to the framework, 4 CCPs did not report any specific concentration add-ons.
380. The data received does not allow ESMA to determine whether this risk was computed as part of the initial margin valuation and how this was done. Notwithstanding this limitation, ESMA looked at the overall margins and compared them with the market impact.
381. For 3 out of those 4 CCPs that did not report specific add-ons, the required margins are much larger than the market impact. For one CCP the market impact is significant although this represents less than 6% of the required margin.

4.5.2.3 Accuracy of the coverage at clearing member level

382. As illustrated in the previous section, overall add-ons collected at CCP level cover the computed concentration risk. However, a large total amount of add-ons at default fund level does not protect correctly the mutualised resources if there is a mismatch at clearing member level between add-ons and concentration risk. Indeed, the market impact costs stemming from a defaulting clearing member's concentrated positions is only covered by the individual resources of this clearing member. Therefore, if the concentration risk is not covered properly at CM level, mutualised resources may still be consumed.
383. As previously shown, the level of add-ons charged at asset class / CCP level can differ widely from the market impact, but this could be explained mostly by the choice of sensitivity parameters.

384. While acknowledging the model limitations, we can assess model risk by regressing the add-ons computed by the CCP to the framework results. Linear regression shows heterogeneous results across CCPs: the framework model statistically explains quite well some concentration models, but poorly others. This might be a sign that concentration models differ widely across CCPs. For example, the R^2 for Commodities Derivatives ranges from 0.22 to 0.97 with an average of 0.59. For fixed income derivatives, it ranges from 0.37 to 0.83 with an average of 0.59.
385. It is also interesting to identify outliers where the market impact uses a large proportion of the required margin, putting the mutualised resources at risk.
386. Some CCPs can display very large market impacts compared to the required initial margin:
- 3 CCPs have more than 6% of their clearing members with a market impact over half of their required margins.
 - 4 CCPs have at least a clearing member whose market impact exceeds its total required margin.
387. If one of the clearing members with a market impact greater than the required margin were to default, it could hit the mutualised resources even without any prior market move.
388. It is therefore important for margin models to be not only conservative overall but also accurate.
389. A model that would build in some conservativeness (i.e. by using a longer margin period of risk) would be conservative most of time for most positions. However, in case a CM builds up some very large positions, the model may not be sufficient to cover the real concentration risk. In such a model, the adequate coverage of the market concentration risk at one point in time may not always demonstrate the robustness of the model to varying portfolios. This is in particular the case for securities, as the cleared portfolios can change a lot on a daily basis.

4.5.2.4 Prudential results on mutualised resources

390. Although clearing members may not always be charged enough to cover the concentration risk, the potential impact on mutualised resources will vary with actual positions and market shocks.
391. To assess those risks, while preserving the anonymity of the individual CCPs assessed under the concentration component, we sized the market impact (MI) and the stress losses over initial margin (STLOIM) relative to the mutualised resources of the relevant default fund (default fund plus skin in the game), which comes from the credit component for the 08 March 2020 (as a reminder, concentration was computed only for this date).
392. In the framework, STLOIM does not include market impact losses. Hence, the losses from market impact should come on top of market to market losses accounted for in the STLOIM. It is therefore useful to map the market impact against the stress losses over initial margin.
393. In Figure 47 below, STLOIM consumption ratio of 0.5 means that the clearing member would consume 50% of the mutualised resources in the credit component scenario before accounting for further market impact losses. A market impact ratio of 0.25 indicates that the equivalent of 25% of mutualised resources could be further used up by the market impact cost under the concentration component assumptions.

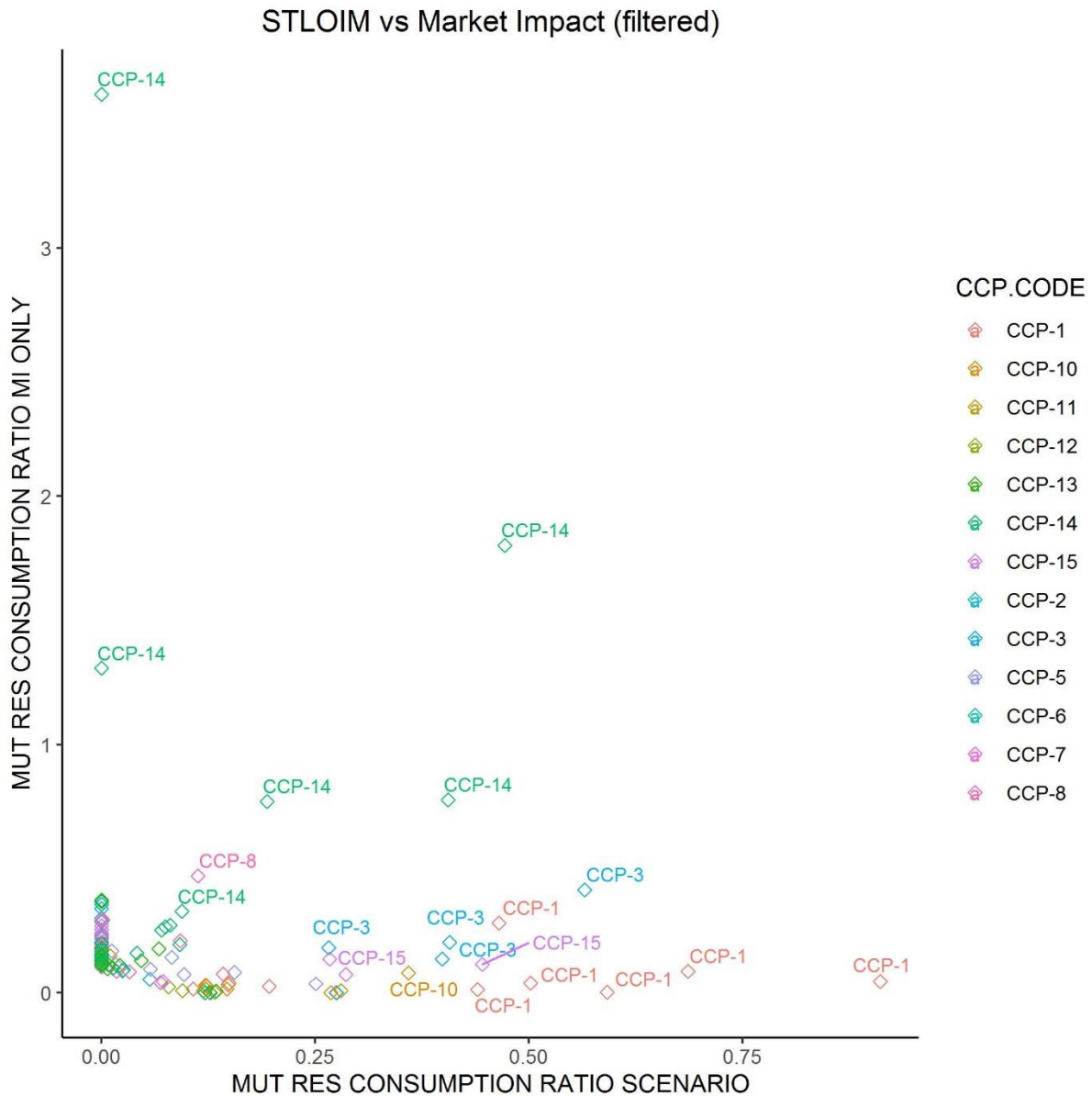


FIGURE 47: STLOIM VS MARKET IMPACT

394. Each point represents a clearing member consumption of mutualised resources for one default fund of the corresponding CCP⁴². We can identify 3 types of clearing members of concern:

- The clearing members (for example of CCP-1) that are already picked up by the credit (STLOIM) analysis. The concentration of their positions does not really change their riskiness for the CCP, i.e. the resources are already widely consumed by the credit component, but the concentration component does not represent an additional significant burden for the CCP in managing the defaults of those clearing members.

⁴² To improve clarity, only the points for which the total mutualised resources consumption is greater than 20% are reported.

- The clearing members (for example of CCP-14) that are not picked up by the chosen credit scenario but could consume a very significant part of the mutualised resources without any adverse market event, simply due to the significant market impact that liquidating their concentrated positions would generate.
- The clearing members (for example of CCP-3) for which the combined effect of market impact and credit losses is very significant.

395. To analyse further, we estimated the minimum value of a combined credit/concentration effect. To do so, we included the market impact into a floor⁴³ to the (absolute) stress losses over initial margin. The floor is computed as follows:

Floor = [Total PNL] + [Total Stressed Margin] – [Concentration cost] with

- [Total PNL]: Total scenario P&L reported by the CCPs for the credit component, considering the whole clearing member portfolio as a single portfolio without considerations of account segregation rules and margins.
- [Total Stressed Margin]: total stressed amount of margin and margin add-ons at clearing member level without considerations of account segregation.
- [Concentration cost]: market impact of liquidating / hedging the portfolio of the clearing member.

⁴³ The reported stressed required margin and total scenario PnL don't reflect the EMIR segregation rules between accounts. Therefore, the (absolute) STLOIM per default fund should not be lower than the sum of the stressed required margin and the total scenario PnL.

Likewise, the computed market impact losses assume no segregation between the accounts. Therefore the (absolute) total stress loss over initial margin should not be lower than Stressed required margin + Total Scenario PnL – Market Impact nor the STLOIM without market impact.

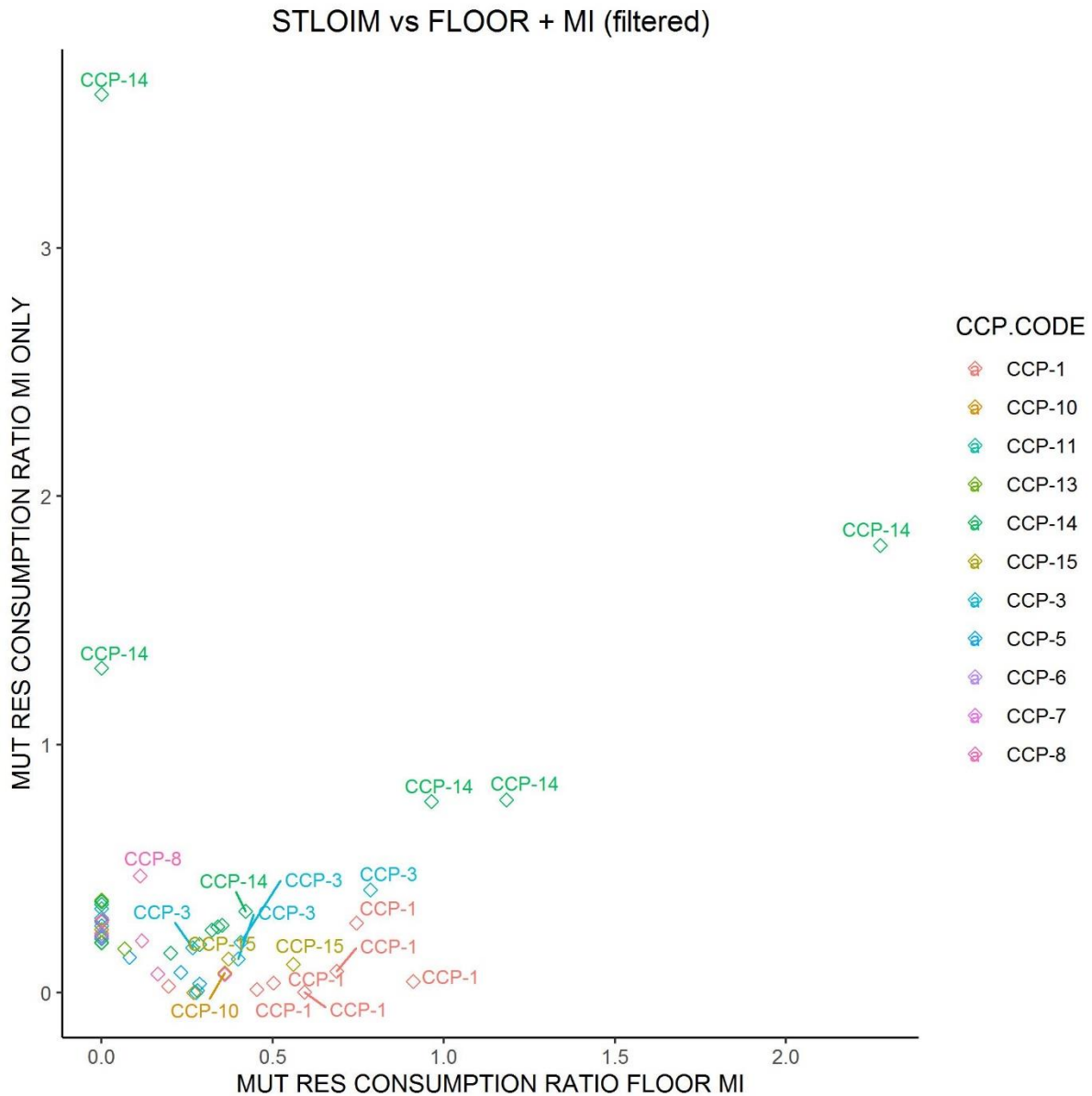


FIGURE 48: STLOIM vs MARKET IMPACT, FLOORED

396. Under the 8 March scenario, we can see that for a few clearing members the floor to absolute ST losses (including market impact) is around or over 50% of the mutualised resources. For some of those clearing members, this is mostly due to addition of the market impact.

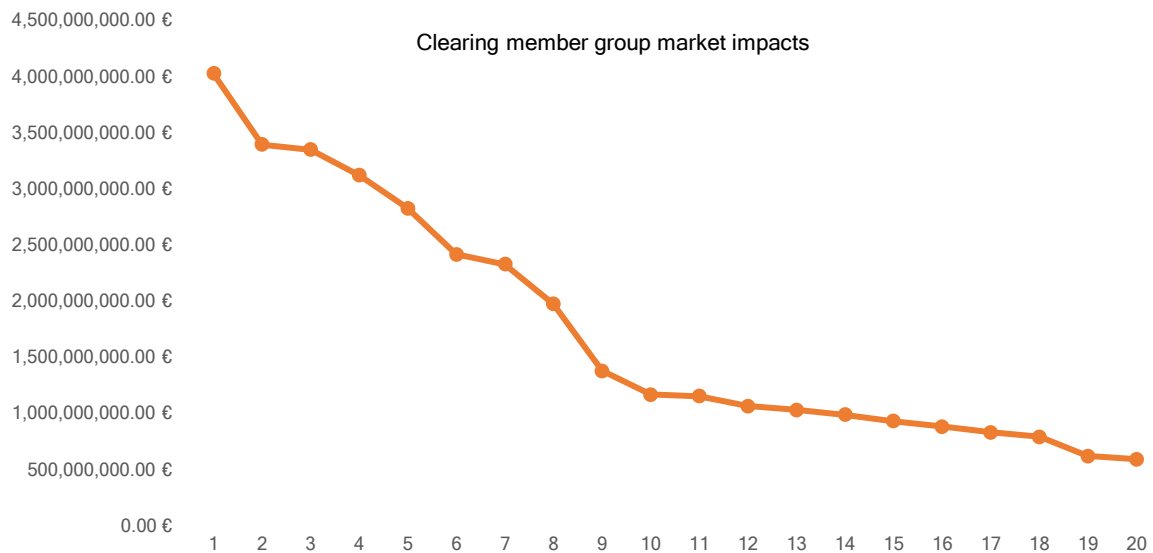
397. This analysis therefore highlights the importance of considering the market impact when sizing the default fund and the default fund contributions of individual clearing members.

4.5.3 Clearing member groups

398. Many clearing member groups have concentrated positions measured by the total market impact their default would have across EU CCPs.

399. The liquidation of the positions of the group with the most concentrated positions would have a market impact of around 4 Bn EUR. 13 groups would cause more than 1 bn EUR of market impact costs each.

400. As reported in section 4.1.3, only 9 clearing member groups have each contributed to CCPs' default funds more than 1B EUR, this confirms that the concentration risk is very significant.



Note: Largest EU-wide total market impacts of clearing member groups.
Sources: ESMA

FIGURE 49: CUMULATIVE MARKET IMPACT, LARGEST CLEARING MEMBERS

4.5.4 Conclusions of Concentration Stress Test Results

401. This first EU-wide concentration analysis shows that concentrated positions represent a significant risk for EU CCPs. Moreover, the overall risk is clustered in one or 2 CCPs for most asset classes.

402. The largest concentration risk can be found in fixed income derivatives (around 20bn EUR). Concentration in commodity derivatives and in the equity segment (securities and derivatives) is very significant as well, with around 9.5bn EUR of concentration risk.

403. The concentration risk is factored in explicitly in a majority of CCPs through dedicated margin add-ons. Although all CCPs have market impact risk, 4 CCPs did not report any concentration add-ons.

404. Margin models need to be not only conservative but also accurate. This is especially the case for liquid markets where large positions can build up very quickly.

405. There is a very large coverage gap between the EU-wide estimated market impact and add-ons, for commodity derivatives and to a lesser extent for equity products.

406. The prudential analysis of the impact of concentrated positions on mutualised resources demonstrates that default fund sizing should take the liquidation costs properly into account.

4.6 Liquidity Stress Test Results

4.6.1 Overview of the results

407. The framework described in part 3.6 was run:

- For a cover-2 per CCP scenario, and an EU-wide scenario where the top 2 groups with the largest combined impact across all CCPs are selected;
- On an aggregated EUR-equivalent basis, and separately for the three major currencies (EUR, GBP, USD).

408. The results presented in this section consist in:

- An overview of the liquid resources available for each CCP, depending on the CCP's rules;
- The overall results, which allow the reader to compare the CCPs. These figures are based for each CCP on the day with the worst⁴⁴ liquidity position over the 7-days liquidity horizon;
- Results per CCP with the evolution of the liquidity position throughout the time horizon.

409. For the sake of readability, most results related to individual CCPs are presented in the Annex. A selected number of individual cases are presented in this section. These are cases where specific trends or results are identified, or which illustrate a particular arrangement to cover liquidity needs..

4.6.2 Allowed usage of collateral

410. The use for credit of an asset held as collateral is determined in the CCP's waterfall and, as explained before, EMIR imposes strict guidance on how this waterfall is composed and used. However, the use for liquidity purposes is generally more flexible, and subject to what is allowed in the CCP's rules and in its contractual relationship with its clearing members. Three cases are possible:

- An asset can be used only to manage the default of the clearing member who deposited it ("clearing member" in Figure 50 below);
- It can be used to provide liquidity when managing the default of a clearing member who is in the same default fund ("DF" in Figure 50). For example, Clearing Member A has posted collateral for default funds D1 and D2, and clearing member B, who is only a member of D2 goes into default. In this case, only the assets deposited by A for its activity in D2 are accessible to the CCP to manage the default of B, but not the assets deposited by A for its activity in D1.
- An asset can be available to the CCP without restriction ("CCP" in Figure 50).

411. Depending on whether liquid resources or tools can be mutualised and used at a global level (CCP) or are segregated (Clearing Member level), the CCP may have more or less resources available to manage the default of a specific member. Figure 50 shows the distribution of collateral and liquidity tools available per allowed usage, for each CCP. Collateral availability rules have been considered

⁴⁴ The liquidity stress test analyses the timeliness of liquid resources and the report also presents this aspect. However, in order to provide a more palatable comparison, charts are displayed with for each CCP the worst day of the 7 day liquidation horizon. Though the day with the least favourable liquidity balance may not be the same for all CCPs, it ensures one can compare how close CCPs are to having exhausted their resources at any point in time.

when computing the liquidity results.

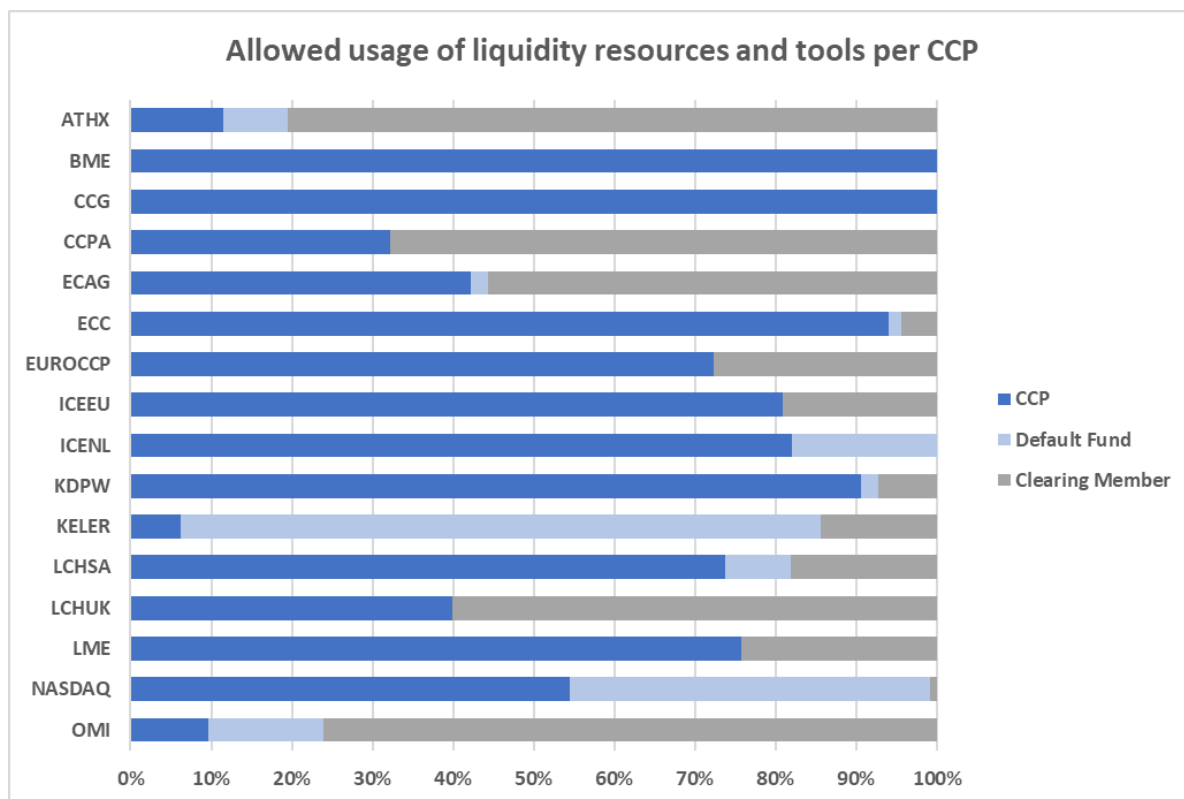


FIGURE 50: ALLOWED USAGE OF LIQUIDITY RESOURCES AND TOOLS PER CCP

412. Additionally, it should be taken into consideration that a defaulter’s collateral becomes available to the CCP at the moment of the default. We have therefore modelled that if part of the defaulter’s collateral was available only at clearing member level, once the said member is selected as a defaulter, its collateral is treated as if available at CCP level.

413. This has a positive impact on the liquidity position of the CCP, especially when one of the two groups assumed to be defaulting has some collateral not used to cover its losses.

4.6.3 Cover-2 per CCP liquidity results – overall results

414. Under the Cover-2 per CCP scenario, we selected for each CCP the 2 entities the simultaneous default of which create the worst liquidity position (as described in section 3.6.1.4).

4.6.3.1 Overall results in EUR-equivalent

415. For this computation, all currencies are aggregated using the FX rates that result from the market scenario. It implicitly assumes all FX trading is possible and without limitations nor transaction costs.

416. The first chart (Figure 51) is in absolute terms (billions EUR on the vertical axis). The second chart (Figure 52) is rescaled to make it more readable as the sizes of the CCPs are heterogeneous.

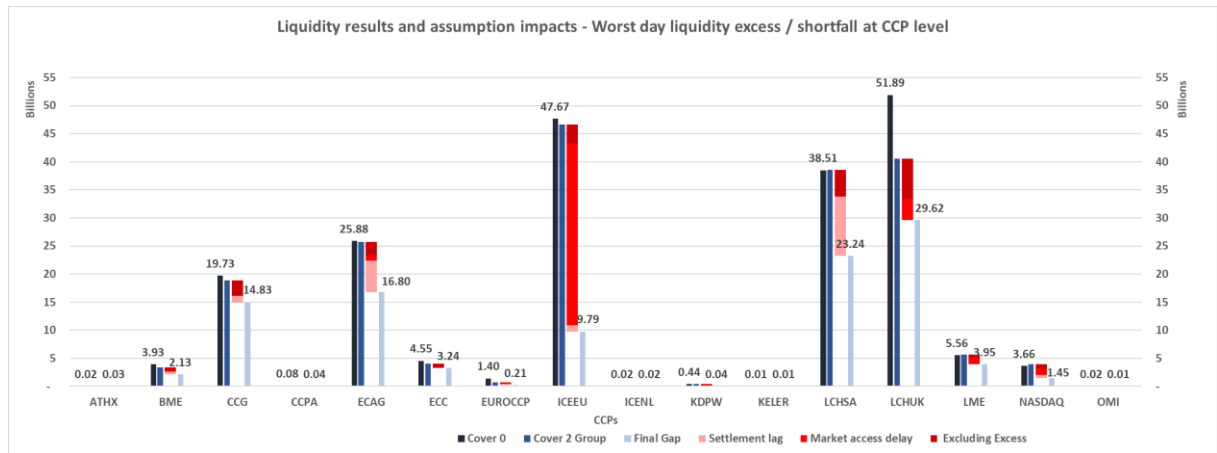


FIGURE 51: COVER-2 PER CCP, EUR EQUIVALENT, OVERALL LIQUIDITY RESULTS

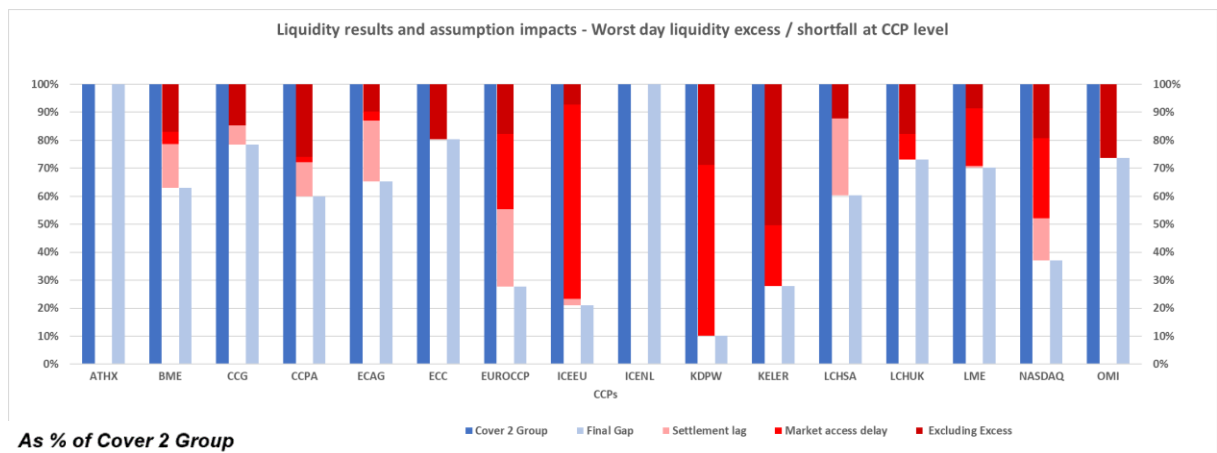


FIGURE 52: COVER-2 PER CCP, EUR EQUIVALENT, OVERALL LIQUIDITY RESULTS, NORMALIZED

417. In each of the charts, the amounts for each CCP, from left to right show:

- The overall liquidity position before assuming any default;
- The position when the 2 groups are in default;
- The effect of the introduction of the 3 liquidity assumptions, in this order: removal of excess collateral, market access delay and settlement lag.

418. A possibly counter-intuitive result is observed: in some cases, the liquidity position is better when two member groups are in default than when there is no default. The explanation is to be found in the availability of collateral. As explained in the previous section, when a member defaults, its assets become available at CCP level. So, when a member with losses less than collateral is defaulting, if its collateral was accessible only at member level, the overall effect is an increase of liquid resources greater than the consumption of liquidity due to the default.

419. Overall it appears that EU CCPs are resilient under this scenario, since they all have liquidity resources left, even after introducing the 3 liquidity assumptions.

4.6.3.2 Overall results in EUR only

420. For the three major currencies (EUR, GBP, USD), we display the collective results of the Cover-2 per CCP scenario. The same methodology as for the EUR-equivalent is used.

421. The results per currency do not make any assumption about the CCP accessing the FX market. It only looks at the gap between needs and resources in each currency.

422. The results show no gaps to report.

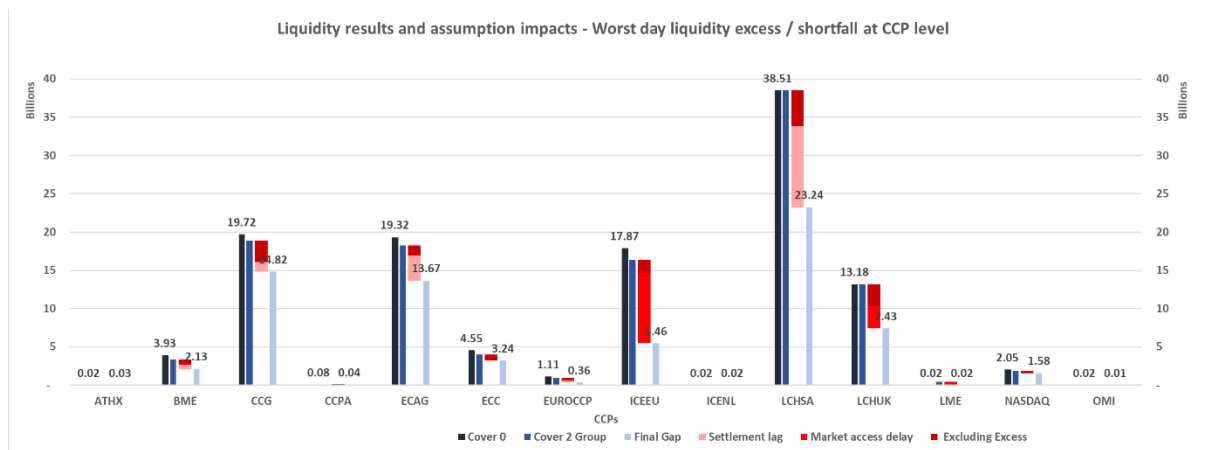


FIGURE 53: COVER-2 PER CCP, EUR ONLY, OVERALL LIQUIDITY RESULTS

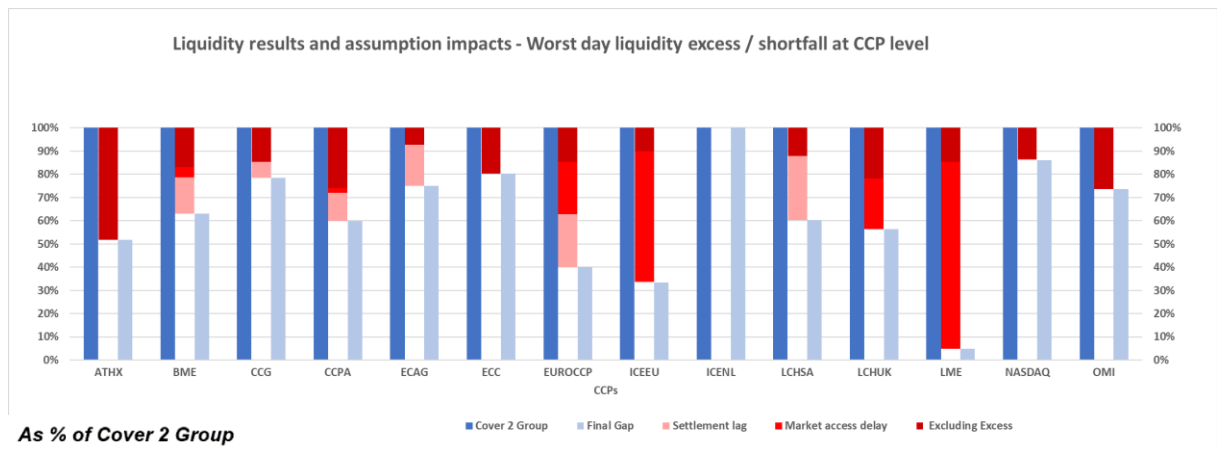


FIGURE 54: COVER-2 PER CCP, EUR ONLY, OVERALL LIQUIDITY RESULTS, NORMALIZED

4.6.3.3 Overall result in GBP

423. A focus on GBP shows that only a small number of CCPs have exposures on this currency (Figure 55). However, under the Cover-2 scenario two (2) CCPs present a minor liquidity shortfall. In order to cover their liquidity needs, both CCPs would need either need to access the spot FX market, or use an alternative access to the UK securities settlement system.

424. Figure 56 shows the same results on a normalized basis. Note that one CCP, namely EuroCCP, cannot be represented on this Figure, as the CCP exhibits a shortfall in the baseline Cover 2 scenario (without assumptions). Since the normalized results are expressed as a percentage of this

baseline Cover 2 result, when this value is already negative the results cannot be shown on the graph, and are displayed as “not applicable”.

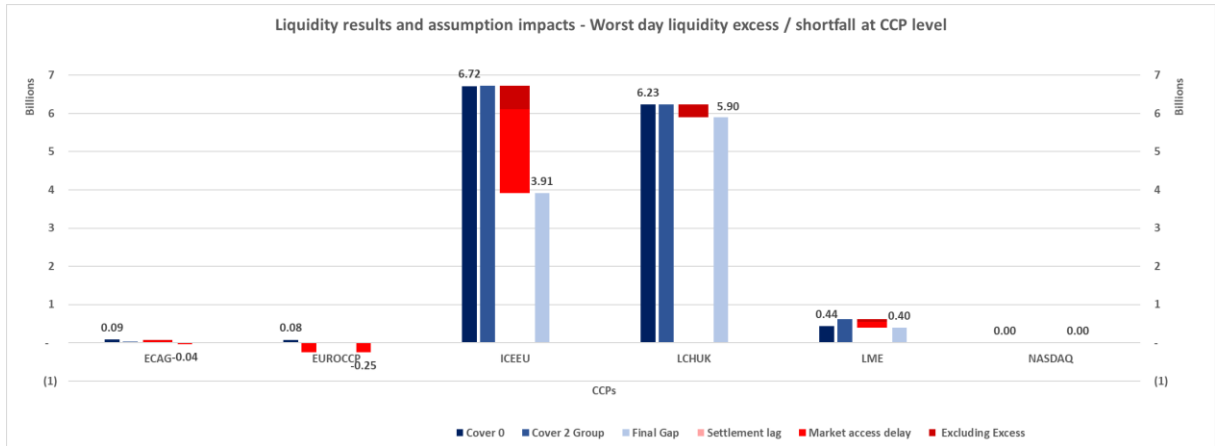


FIGURE 55: COVER-2 PER CCP, GBP ONLY, OVERALL LIQUIDITY RESULTS

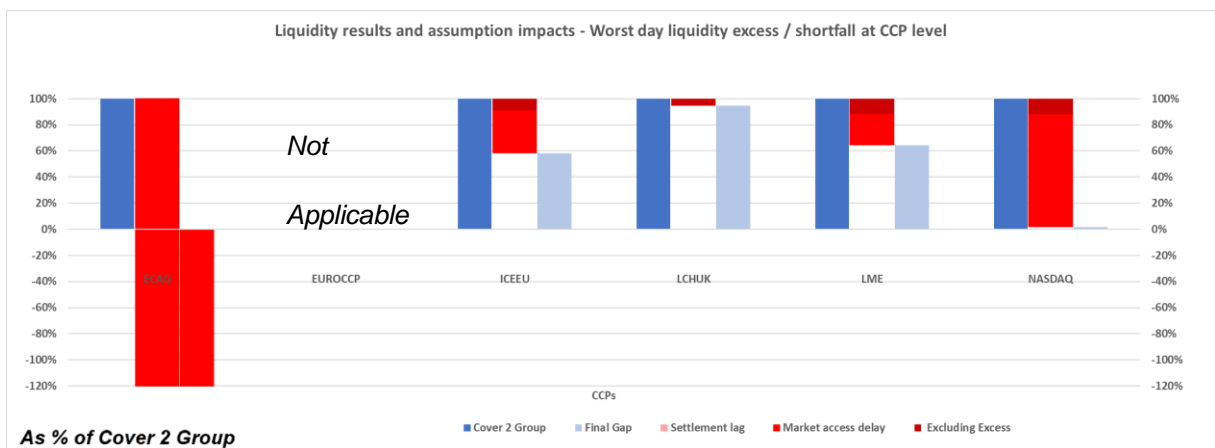


FIGURE 56: COVER-2 PER CCP, GBP ONLY, OVERALL LIQUIDITY RESULTS, NORMALIZED

4.6.3.4 Overall results in USD.

425. Only five (5) CCPs have exposures in USD. Under the Cover-2 scenario, one (1) CCP shows a liquidity gap of 1.89 Bn USD (ECAG), meaning that this CCP would need to access the spot FX market in order to cover that amount under the worst-case scenario. Note that as the FX market is assumed to be sufficiently liquid, we would not expect this CCP to face an actual liquidity shortfall.

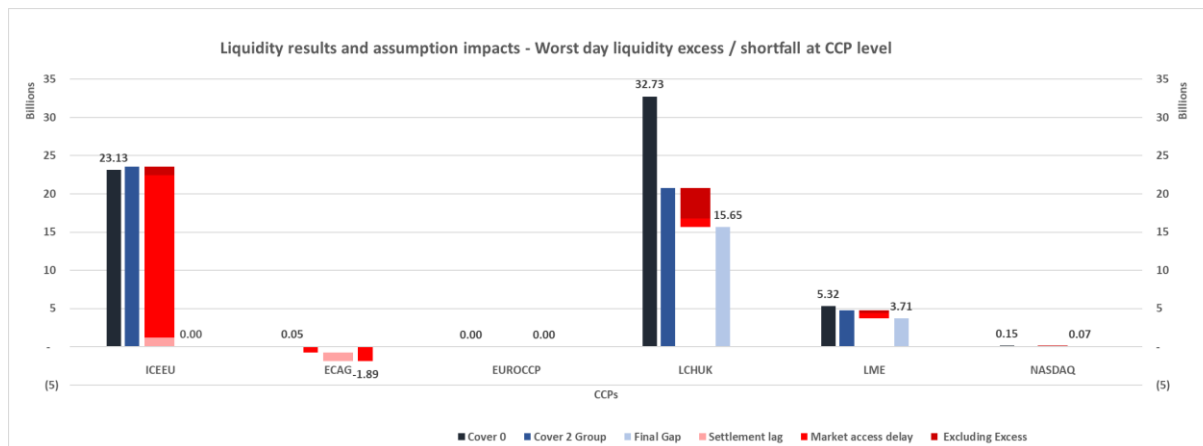


FIGURE 57: COVER-2 PER CCP, USD ONLY, OVERALL LIQUIDITY RESULTS

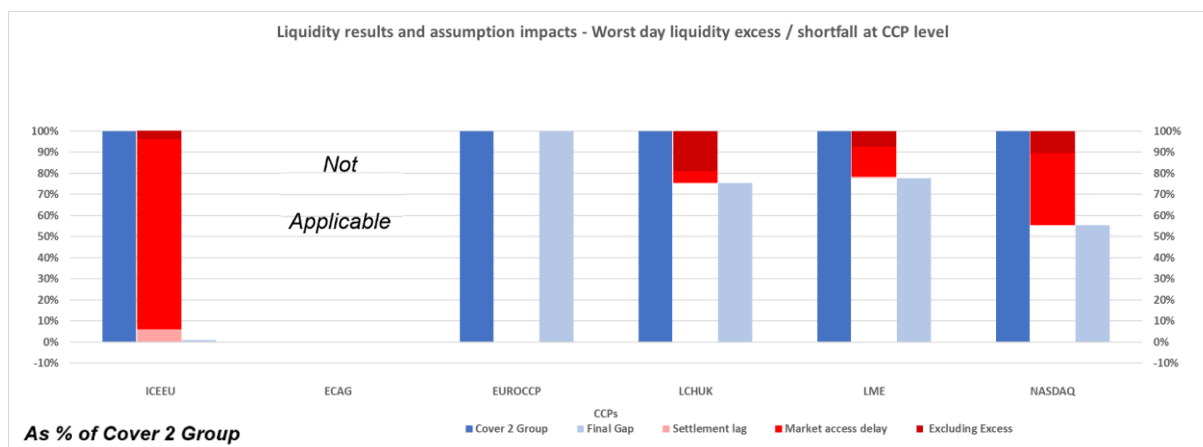


FIGURE 58: COVER-2 PER CCP, USD ONLY, OVERALL LIQUIDITY RESULTS, NORMALIZED

4.6.4 Cover-2 per CCP liquidity results – individual results EUR-equivalent

426. The previous results show for all CCPs the worst day over the liquidation horizon. This helped compare CCPs and reduce the dimensionality of the problem.

427. This section presents, for a selection of CCPs, a detailed analysis of the liquidity position for each of the 7 days following the stressed event. All remaining CCP results are presented in the Annex (section 6.2.1).

4.6.4.1 Cases of CCG and LCHSA in EUR equivalent

428. Below are presented the detailed liquidity results over the 7-days liquidity horizon for CCG and LCHSA. These two CCPs illustrate the differences in access to the central bank described in the framework. It is also interesting to analyse jointly these CCPs, as they are both interoperable, and are both active on the repo market, which requires significantly more liquidity than other markets.

429. In line with the Eurosystem’s monetary policy framework and its license as a credit institution LCHSA has a routine access to overnight central bank credit, which can be used to cover possible liquidity

needs and is displayed in grey (Figure 60). While, Figure 59 shows that CCG relies on the extension of intraday central bank credit into overnight under a penalty regime which is displayed in orange. As explained in the methodological section, 2 metrics are presented in the graphs. The graph on the left presents the liquidity balance (excess if positive or shortfall if negative) at CCP level if we assume that netting between default funds does not apply. On the contrary, the graph on the right shows the remaining resources at both CCP and default fund level with netting.



FIGURE 59 : DETAILED LIQUIDITY RESULTS FOR CCG, EUR-EQUIVALENT

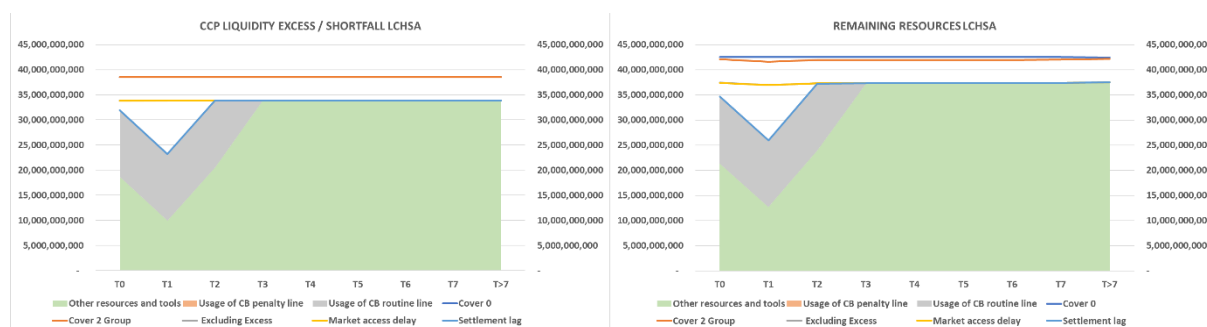


FIGURE 60 : DETAILED LIQUIDITY RESULTS FOR LCHSA, EUR-EQUIVALENT

4.6.5 EU-wide Cover-2 liquidity scenario – overall results

430. The same methodology is applied to the EU-wide Cover-2 scenario. Under this scenario, the two member groups are selected at the EU-wide level (as described in section 3.6.1.4), therefore for a given CCP these may not be the most impactful defaults. As a consequence, the results are at most as severe as for the Cover-2 per CCP scenario, and mostly they are less impactful for each CCP taken in isolation.

4.6.5.1 Overall results – EUR equivalent

431. The results are displayed in the same format as for the Cover-2 per CCP results. It should be noted that some CCPs have more liquidity resources left for this EU-wide scenario than at individual CCP level. This is because the selected defaulting groups are less impactful for these CCPs.

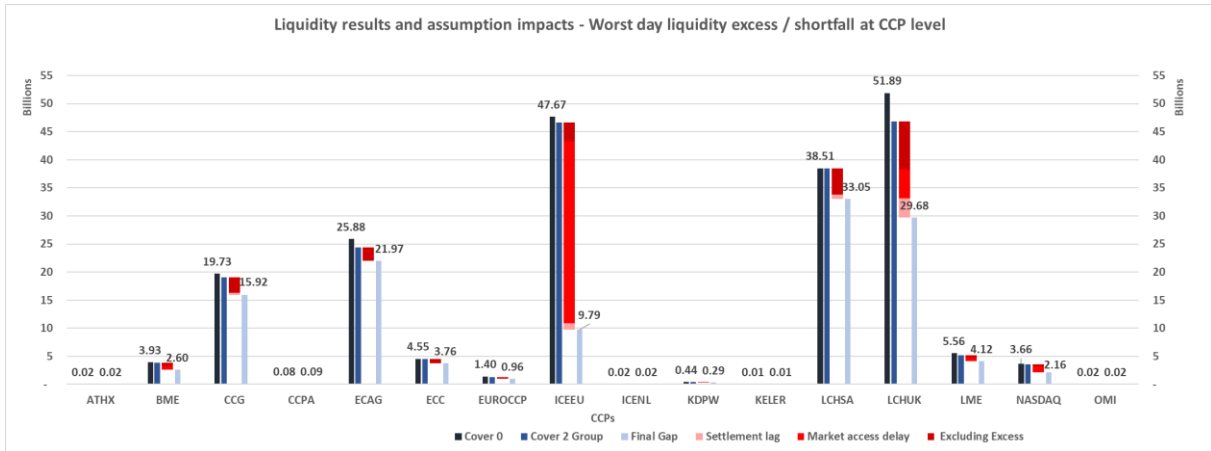


FIGURE 61: EU-WIDE COVER-2, EUR EQUIVALENT, OVERALL LIQUIDITY RESULTS

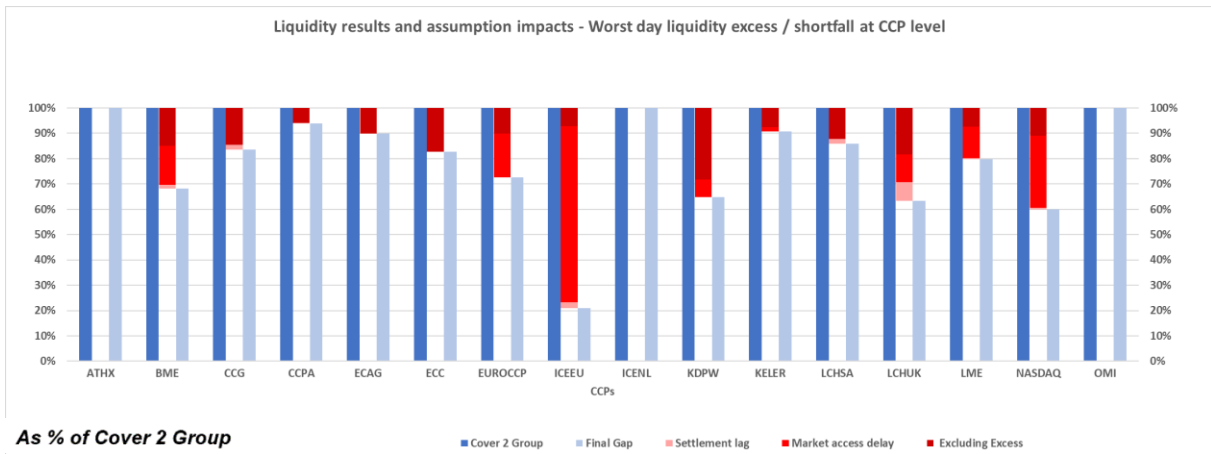


FIGURE 62: EU-WIDE COVER-2, EUR EQUIVALENT, OVERALL LIQUIDITY RESULTS NORMALIZED

4.6.5.2 Overall results – EUR only

432. The results for EUR-only compare to the results for EUR-equivalent. No shortfall has been identified for this currency under this scenario.

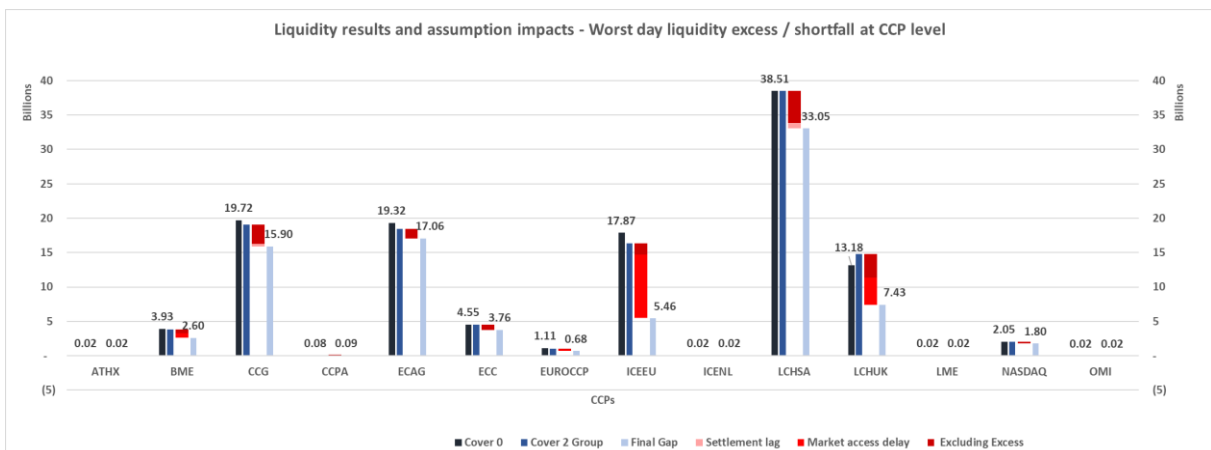


FIGURE 63: EU-WIDE COVER-2, EUR ONLY, OVERALL LIQUIDITY RESULTS

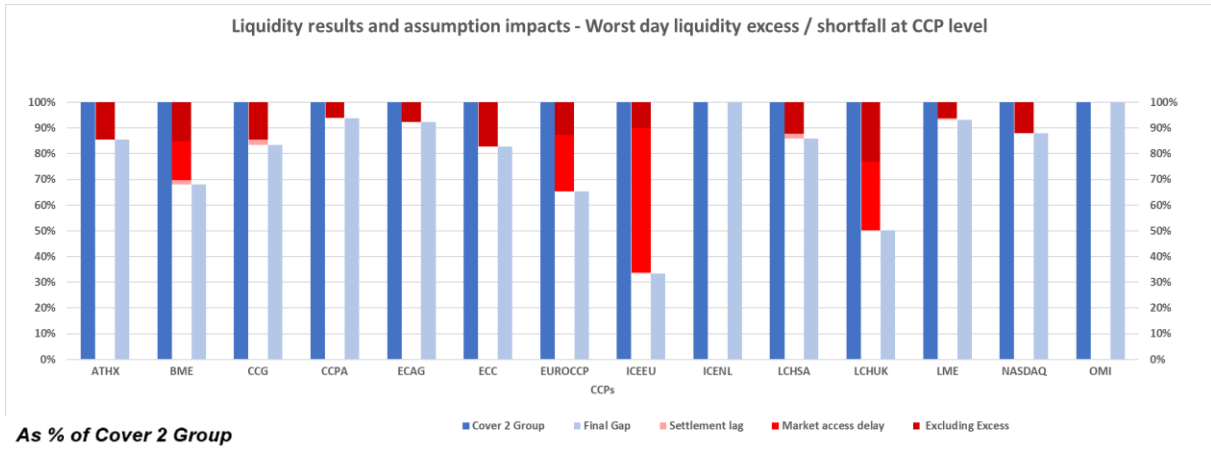


FIGURE 64: EU-WIDE COVER-2, EUR ONLY, OVERALL LIQUIDITY RESULTS NORMALIZED

4.6.5.3 Overall results – GBP

433. The GBP results are only relevant to a limited number of CCPs. Under this scenario all CCPs present an excess of liquidity in GBP.

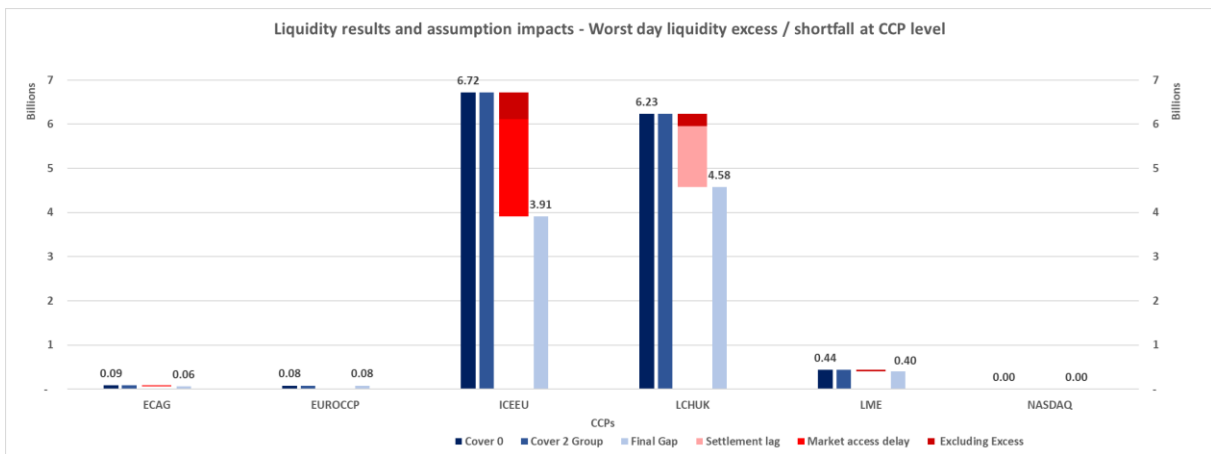


FIGURE 65: EU-WIDE COVER-2, GBP ONLY, OVERALL LIQUIDITY RESULTS

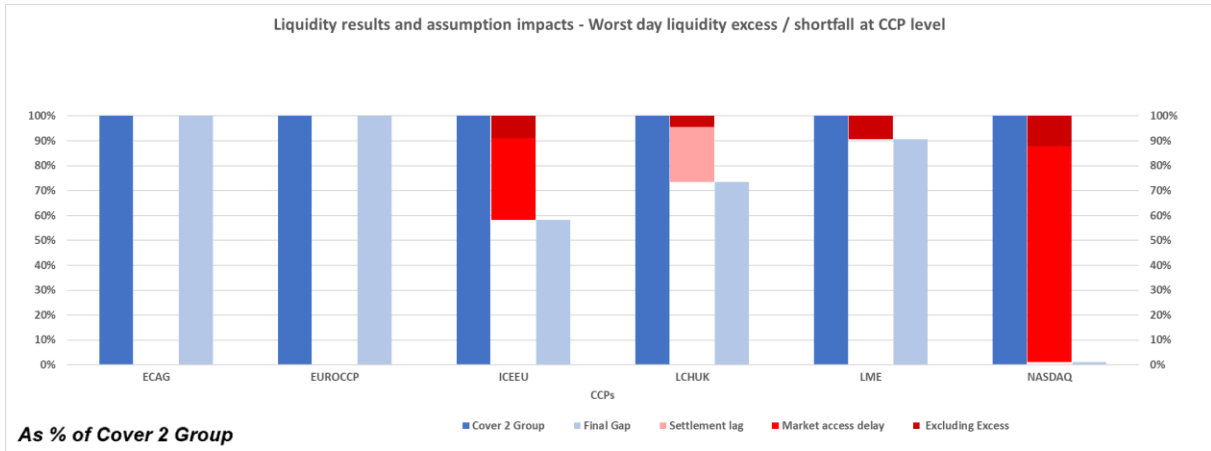


FIGURE 66: EU-WIDE COVER-2, GBP ONLY, OVERALL LIQUIDITY RESULTS

4.6.5.4 Overall results – USD

434. Under the USD EU-wide Cover-2 scenario, ECAG displays a minor shortfall of 320Mn. This only implies that the CCP would need to convert an equal amount of resources from a different currency by accessing the FX market. The trading of this quantity of EUR/USD on the spot market is not questioned in this exercise.

435. As indicated previously, this is not a sign of a shortfall.

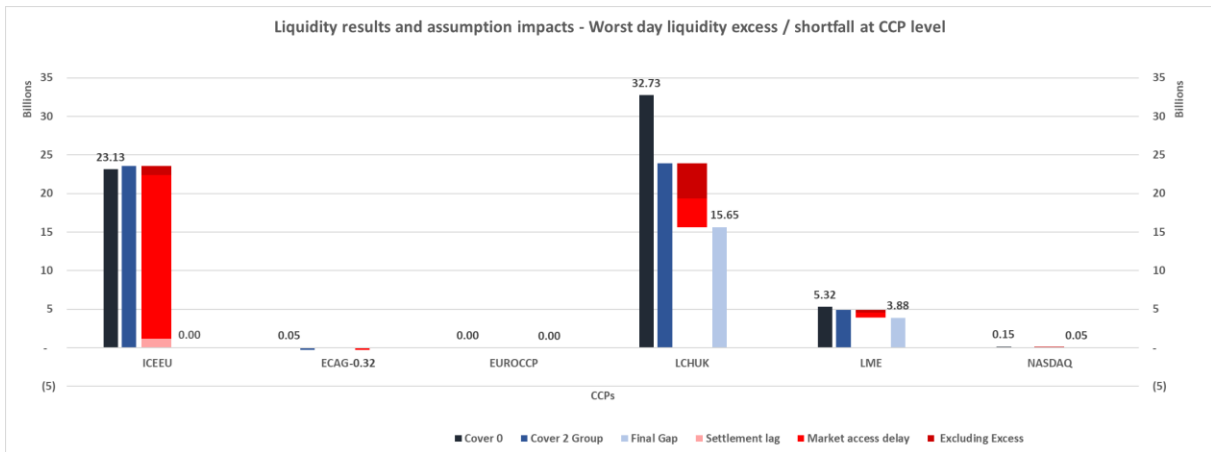


FIGURE 67: EU-WIDE COVER-2, USD ONLY, OVERALL LIQUIDITY RESULTS

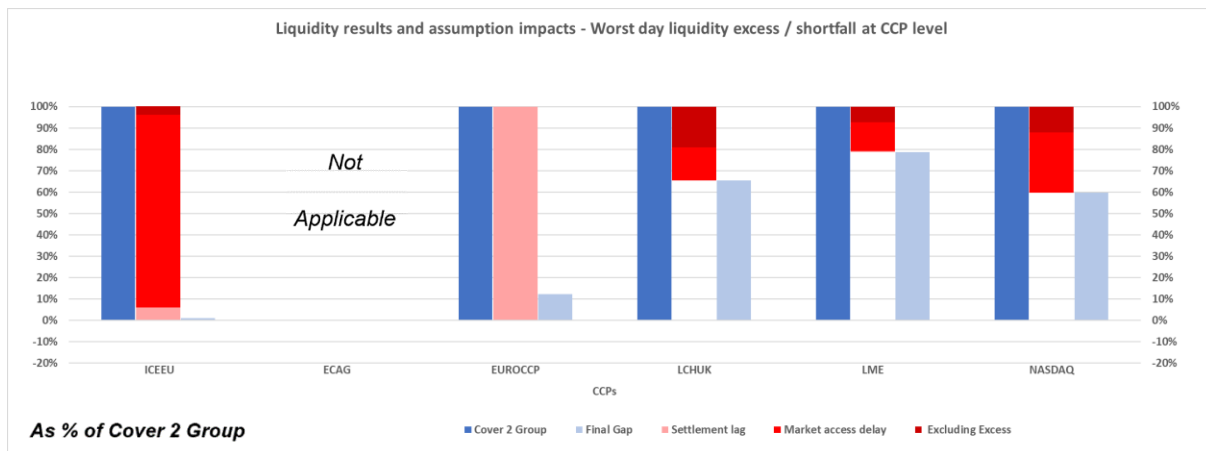


FIGURE 68: EU-WIDE COVER-2, USD ONLY, OVERALL LIQUIDITY RESULTS

4.6.6 EU-wide Cover-2 liquidity scenario – individual results EUR Equivalent

436. As for the Cover-2 per CCP scenario, individual results over a 7-days horizon have been computed for all 16 CCPs.
437. All individual results are presented in the Annex (section 6.2.2). This section focuses on one CCP only, EuroCCP.
438. The case of EuroCCP has been chosen because it is an example of a counter-intuitive result: the CCP has a more favourable liquidity position on T+1, when the settlement lag is applied. This is because the CCP expects to pay out more settlement flows than it expects to receive on that day.

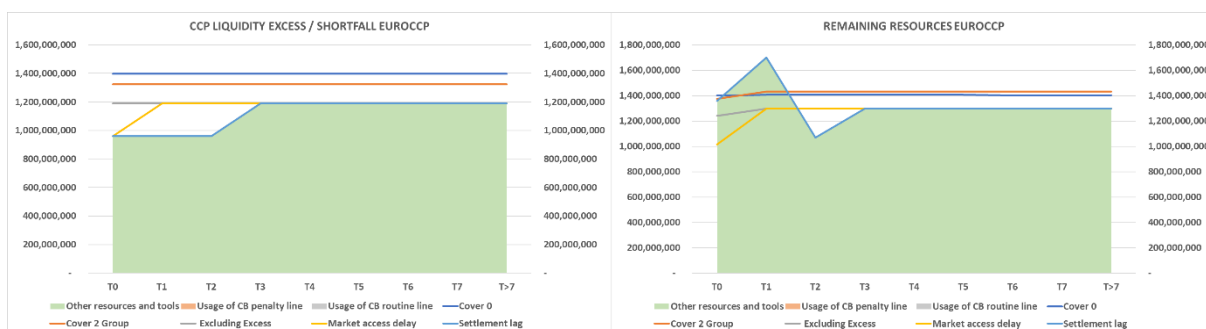


FIGURE 69: DETAILED RESULTS FOR EUROCCP

4.6.7 Conclusions of Liquidity Stress Test Results

439. Overall, and even though the exercise is not designed as a “pass or fail” test, EU CCPs prove to be resilient under the implemented scenarios and tested assumptions.
440. This is to be interpreted as an additional finding to credit stress test results and is specific to the date selected as well as the assumptions retained for the exercise.
441. Only a few CCPs need immediate access to the FX market to cover specific needs in USD or GBP, however the amounts are negligible compared to the size of the spot FX market.

5 Conclusions

442. The third EU-wide CCP stress test aimed to assess the resilience of all 16 authorised EU CCPs against adverse market developments. In accordance with the methodology published in April 2019, this exercise covered both credit and liquidity risk, with targeted improvements compared to the previous exercise. In addition, this exercise included a new concentration risk component, which aimed to assess the impact of liquidation costs for concentrated positions. As with the previous exercise, the ESRB has delivered the narrative and the adverse scenario used for this 3rd stress test exercise.
443. As with all exercises of this scale and type, it is subject to a number of limitations. While residual risks from the in-scope components have been highlighted in the report, CCPs are also subject to other types of risks that are either not or only partially covered in the exercise, but which could still in isolation challenge their resilience. For example, operational, legal and any type of business risk have been left outside of the scope of the exercise. ESMA remains committed to further improve and evolve the methodology and scope of the future CCP stress tests.
444. The report analysed the financial resources held by the 16 in-scope CCPs as of 8 March 2019. The aggregate amount of resources available to CCPs on this reference date was approximately 335 billion EUR, an increase compared to the previous exercise (271 billion EUR). No significant evolution was observed in the allocation of resources between the different tranches of prefunded resources (i.e. margins, skin-in-the-game and mutualized resources) nor in the breakdown of resources between different assets types.
445. As highlighted during the two previous exercises, the analysis of the network of CCPs and clearing participants showed that CCPs can be highly interconnected through common clearing members. In particular, most CCPs are connected to several of the ten biggest EU clearing member groups.
446. When looking at interconnectedness via custodians, the analysis also showed some level of interconnectedness, as multiple CCPs rely on a small number of cash and securities custodians, with in particular two CSDs and one non-EU custodian bank playing a central role. Besides interconnectedness, dependence on a few commercial entities may be a source of operational risk concerns, especially in case of technical disruptions.
447. Concerning common liquidity providers, there was no strong evidence of single financial groups committing to providing liquidity to many CCPs at the same time.
448. The credit stress test results have been computed for two default scenarios and on two reference dates (8 March 2019 and 21 December 2018). Under the Cover-2 per CCP scenario, ESMA assessed the resilience of each CCP to the default of its top-2 clearing members groups. For the March date, one CCP would have to use all its prefunded resources, leaving approximately 266 million EUR of residual losses. These residual losses would have to be covered with additional non-prefunded resources that the CCP had the right to call from its non-defaulting members, leaving no losses uncovered. In all other cases, the prefunded resources would be sufficient to cover the resulting losses. For the core scenarios maximising the amount of loss beyond margin, only three out of the sixteen CCPs faced under at least one of the assumed scenarios a consumption rate that was greater than 50% of prefunded resources beyond margin. Scenarios used to maximise the % consumption of prefunded resources highlighted two smaller default funds for which the scenario would cause a high % consumption accompanied with lower amounts of losses. The prefunded resources would be enough to cover the losses. We analysed the sensitivity of the results to changes of the severity of the market shocks. Assuming a 30% decrease in severity, there would be no shortfall of prefunded resources. If instead one would further increase the already extreme

shocks by 20%, more CCPs would be impacted showing an increased sensitivity in some cases, without however raising any additional, systemically relevant concerns at individual CCPs.

449. For the EU-wide cover-2 scenario, we selected two clearing members groups as defaulting at an EU-wide level, i.e. the same two clearing member groups for all CCPs. The combination of defaults that led to the above highlighted shortfall would have a rather limited impact on the other CCPs, with the % consumption of prefunded resources being below 20%. When we looked for combinations of defaults that would be more impactful on an EU-wide level by hitting multiple CCPs at the same time, the results were similar. A smaller shortfall of prefunded resources for the same CCP for one of the dates and a higher consumption at other CCPs, but still in all considered scenarios a consumption of prefunded resources that was lower than 50%. Moreover, in the knock-on analysis we saw no evidence of systemic implications from second round effects to non-defaulting members via the risk-sharing mechanism of CCPs under the considered EU-wide scenarios.
450. The reverse stress tests analysis assessed the sensitivity of the credit stress results to stepwise increases in both the number of defaulting groups and the severity of market shocks. Overall, the analysis shows that incremental changes in market shocks severity are more harmful than increases in the number of defaulting members.
451. For the first time, a concentration component was included in this year's stress test exercise. This first concentration analysis showed that concentrated positions could represent a significant risk for EU CCPs.
452. For most asset classes, concentrated positions are clustered in one or two CCPs. EU-wide, the largest concentration risk can be found in Fixed Income (around 20bn EUR). Concentration in commodity derivatives and in the equity segment (securities and derivatives) is very significant as well, with around 9.5bn EUR of concentration risk.
453. The analysis found that concentration risk is factored in explicitly in a majority of CCPs, through dedicated margin add-ons. Although all CCPs have market impact risk, 4 CCPs did not report any concentration add-ons. At EU level, reported concentration add-ons are much lower than market impact risk for commodity derivatives, and to a lesser extent for equity products.
454. However, a focus on individual clearing members coverage shows that concentration risk is not always covered properly at this level, as 4 CCPs have at least a clearing member whose market impact exceeds its total required margin. This highlights the importance for margin models to not only be conservative but also accurate in capturing concentration risk.
455. Finally, the prudential analysis of the impact of concentrated positions on mutualised resources demonstrated that CCPs should properly take into account liquidation costs when sizing their default funds.
456. As in the previous exercise, the liquidity stress test component gives an understanding of the liquidity challenges faced by EU CCPs. The exercise estimated the resilience of EU CCPs under both a Cover-2 per CCP and an EU-wide Cover-2 liquidity scenario, combined with market price shocks and a series of assumptions (no excess margin, 1-day market access delay, 2-days settlement lag, no access to FX market). Defaulting entities were selected as the ones which maximized the liquidity exposures when all assumptions were applied.
457. Overall, the liquidity results showed EU CCPs to be resilient under the implemented scenarios and tested assumptions. Only a few CCPs exhibit a shortfall in at least one currency, which means that they would need to transform some of their resources available in one currency into another currency in order to match their liabilities in a timely manner. However, the amounts remain negligible compared to the size of the FX market.

458. As with the two previous exercises, this year's stress test exercise showed that EU CCPs are overall resilient to common shocks and multiple defaults. However, the credit stress test highlighted differences in resilience between CCPs under the selected market stress scenarios, although no systemic risk has been identified. Similarly, the liquidity stress test showed EU CCPs to be resilient under the considered scenarios and did not reveal any systemic risk. Finally, the new concentration component added a new dimension to the exercise and highlighted the need for EU CCPs to accurately account for liquidation cost within their risk framework.

6 Annexes

6.1 List of CCPs included in the scope of the exercise

no	CCP
1	Athens Exchange Clearing House
2	BME Clearing
3	Cassa di Compensazione e Garanzia S.p.A.
4	CCP Austria Abwicklungsstelle für Börsengeschäfte GmbH
5	European Commodity Clearing
6	Eurex Clearing AG
7	European Central Counterparty N.V.
8	ICE Clear Europe
9	ICE Clear Netherlands B.V.
10	KDPW_CCP
11	Keler CCP
12	LCH.Clearnet SA
13	LCH.Clearnet Ltd
14	LME Clear Ltd
15	Nasdaq OMX Clearing AB
16	OMIClear – C.C., S.A.

6.2 Liquidity Stress Test Results

6.2.1 Individual results under the Cover 2 per CCP scenario in EUR Equivalent

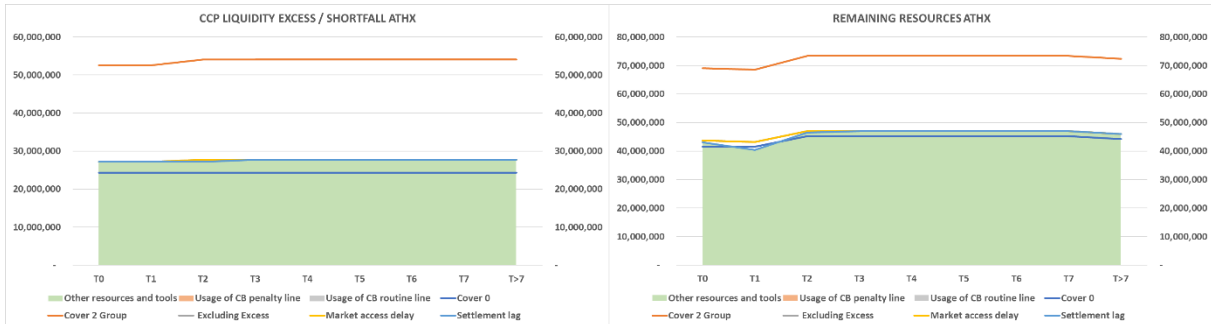


FIGURE 70: DETAILED LIQUIDITY RESULTS FOR ATHX, COVER-2 PER CCP, EUR-EQUIVALENT

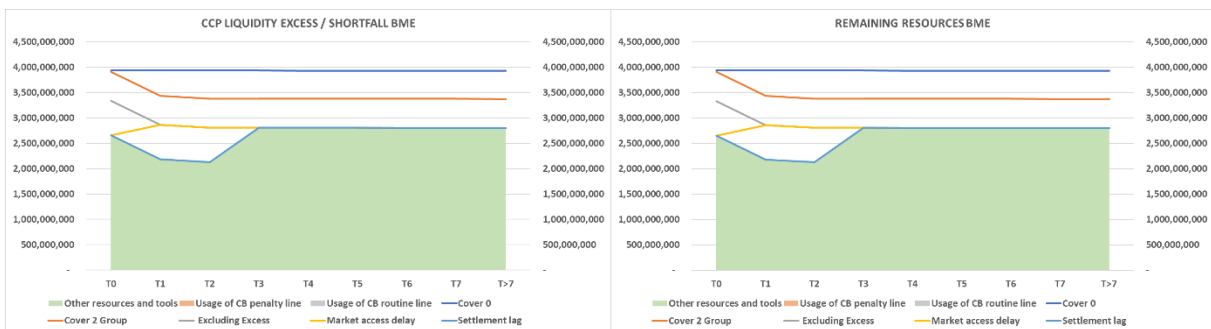


FIGURE 71: DETAILED LIQUIDITY RESULTS FOR BME, COVER-2 PER CCP, EUR-EQUIVALENT

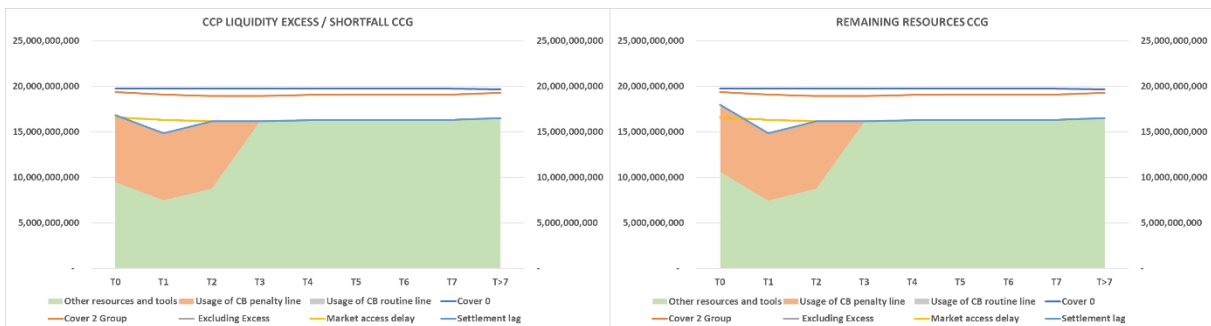


FIGURE 72: DETAILED LIQUIDITY RESULTS FOR CCG, COVER-2 PER CCP, EUR-EQUIVALENT

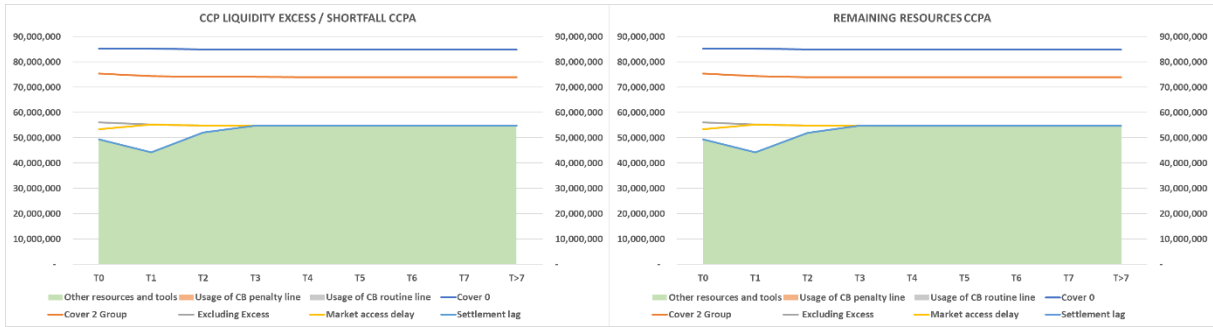


FIGURE 73: DETAILED LIQUIDITY RESULTS FOR CCPA, COVER-2 PER CCP, EUR-EQUIVALENT

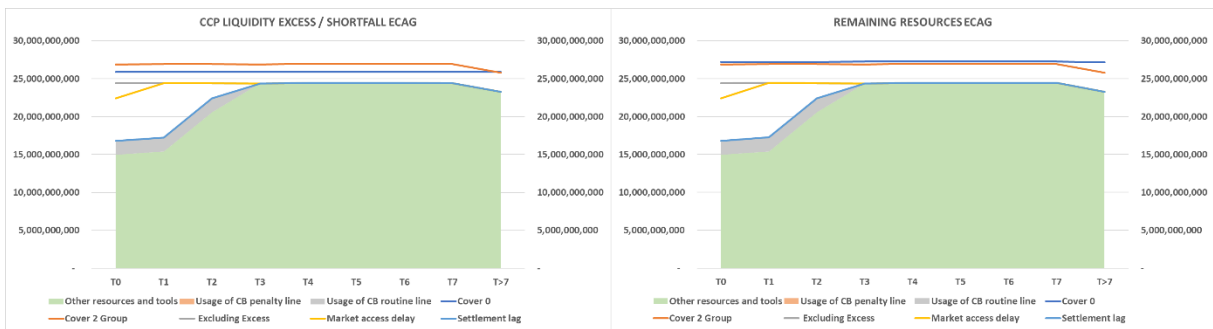


FIGURE 74: DETAILED LIQUIDITY RESULTS FOR ECAG, COVER-2 PER CCP, EUR-EQUIVALENT



FIGURE 75: DETAILED LIQUIDITY RESULTS FOR ECC, COVER-2 PER CCP, EUR-EQUIVALENT

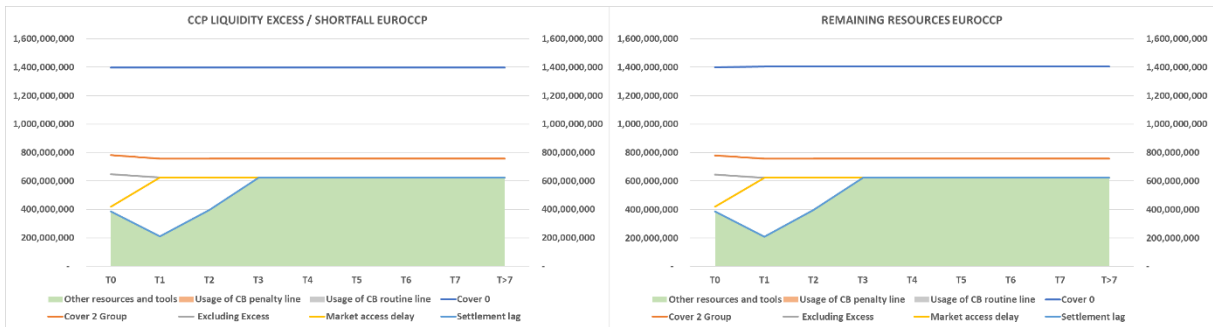


FIGURE 76: DETAILED LIQUIDITY RESULTS FOR EUROCCP, COVER-2 PER CCP, EUR-EQUIVALENT

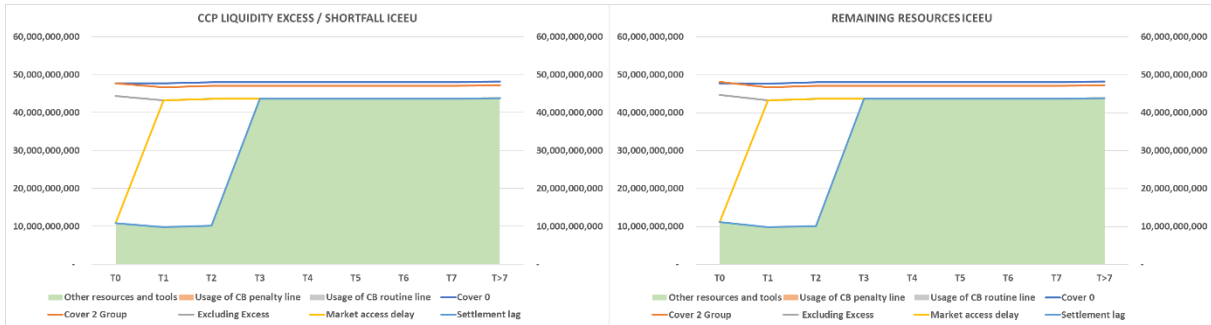


FIGURE 77: DETAILED LIQUIDITY RESULTS FOR ICEEU, COVER-2 PER CCP, EUR-EQUIVALENT

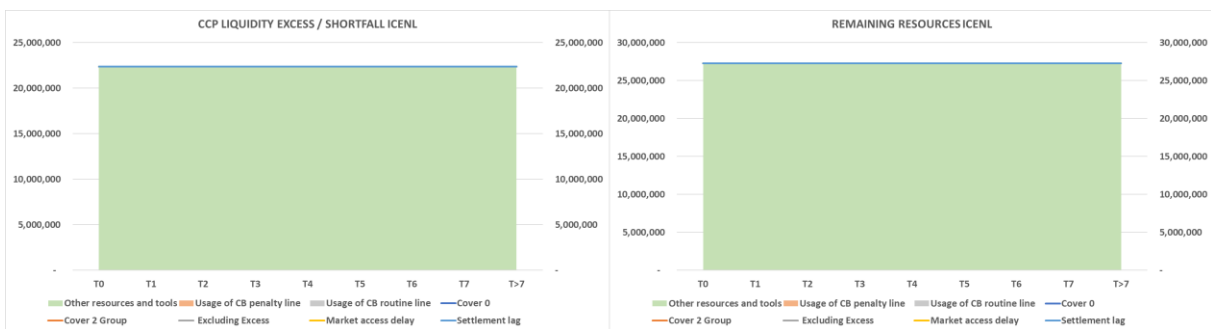


FIGURE 78: DETAILED LIQUIDITY RESULTS FOR ICENL, COVER-2 PER CCP, EUR-EQUIVALENT



FIGURE 79: DETAILED LIQUIDITY RESULTS FOR KDPW, COVER-2 PER CCP, EUR-EQUIVALENT

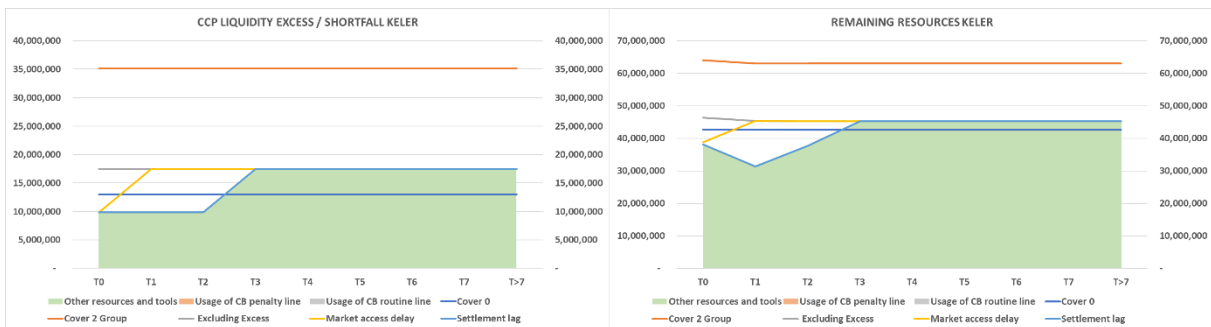


FIGURE 80: DETAILED LIQUIDITY RESULTS FOR KELER, COVER-2 PER CCP, EUR-EQUIVALENT



FIGURE 81: DETAILED LIQUIDITY RESULTS FOR LCHSA, COVER-2 PER CCP, EUR-EQUIVALENT

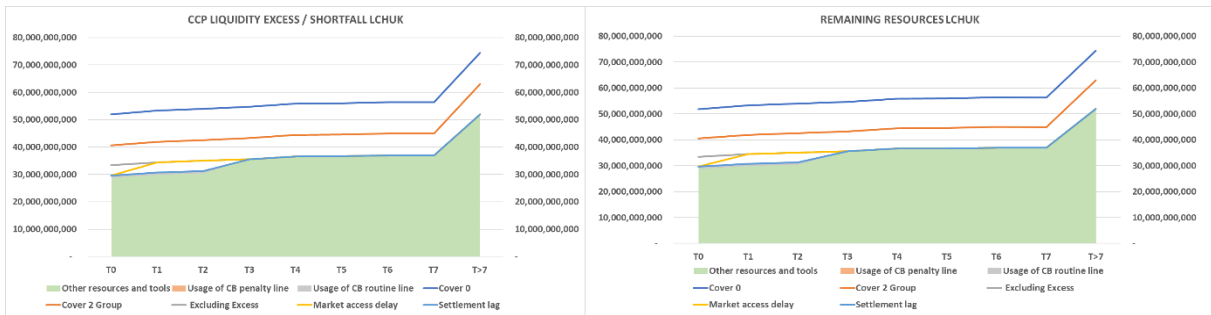


FIGURE 82: DETAILED LIQUIDITY RESULTS FOR LCHUK, COVER-2 PER CCP, EUR-EQUIVALENT

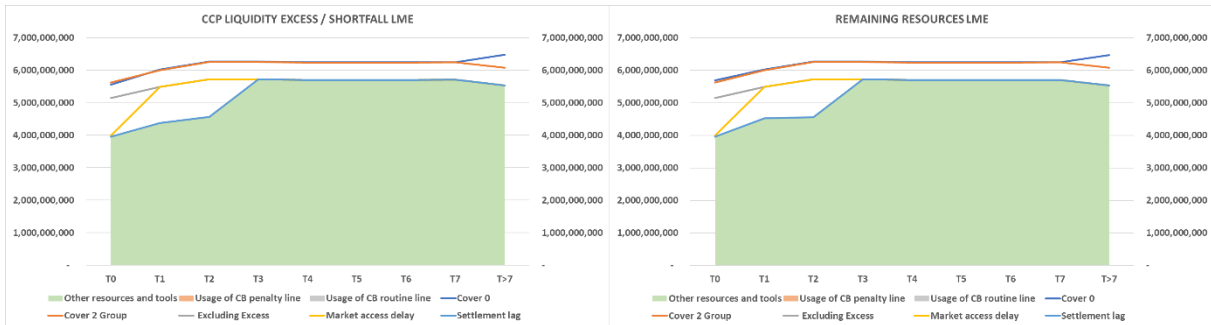


FIGURE 83: DETAILED LIQUIDITY RESULTS FOR LME, COVER-2 PER CCP, EUR-EQUIVALENT

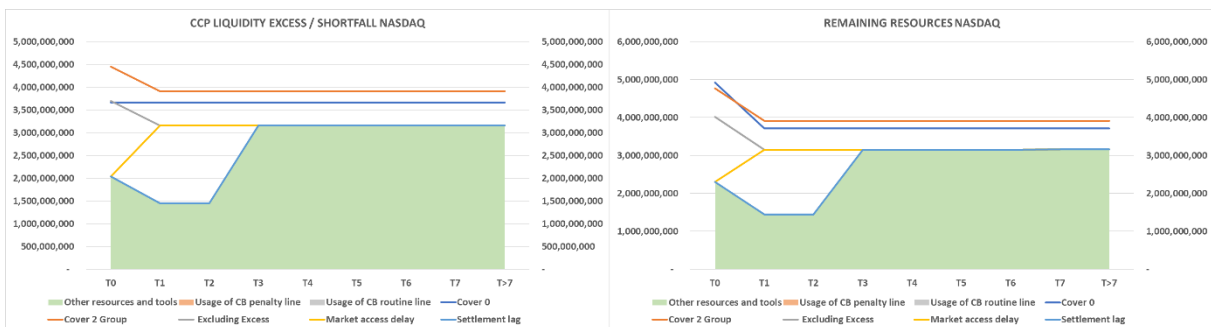


FIGURE 84: DETAILED LIQUIDITY RESULTS FOR NASDAQ, COVER-2 PER CCP, EUR-EQUIVALENT



FIGURE 85: DETAILED LIQUIDITY RESULTS FOR OMI, COVER-2 PER CCP, EUR-EQUIVALENT

6.2.2 Individual results under the EU Wide scenario in EUR Equivalent

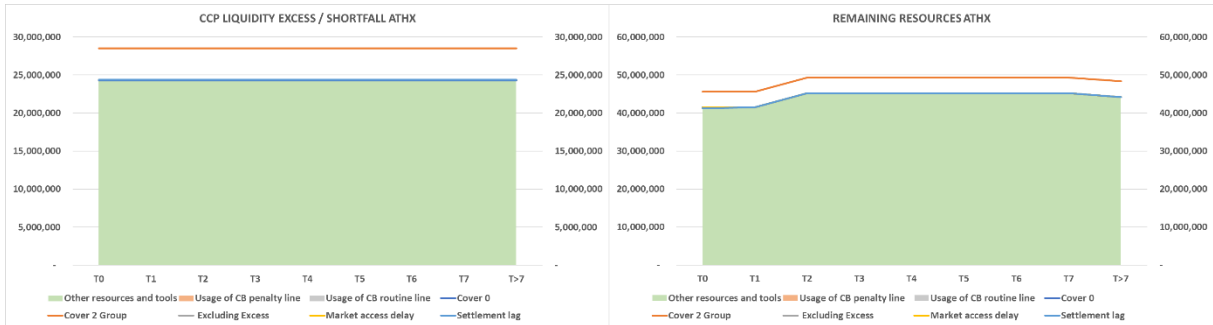


FIGURE 86: DETAILED LIQUIDITY RESULTS FOR ATHX, EU-WIDE COVER-2, EUR-EQUIVALENT



FIGURE 87: DETAILED LIQUIDITY RESULTS FOR BME, EU-WIDE COVER-2, EUR-EQUIVALENT

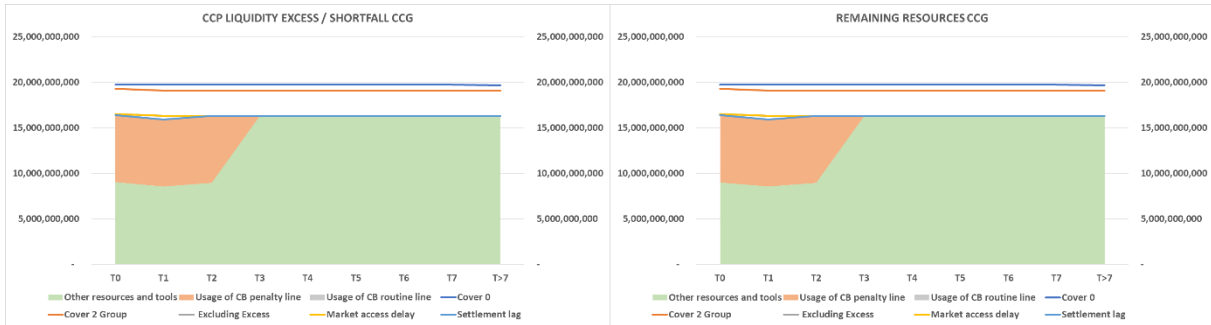


FIGURE 88: DETAILED LIQUIDITY RESULTS FOR CCG, EU-WIDE COVER-2, EUR-EQUIVALENT

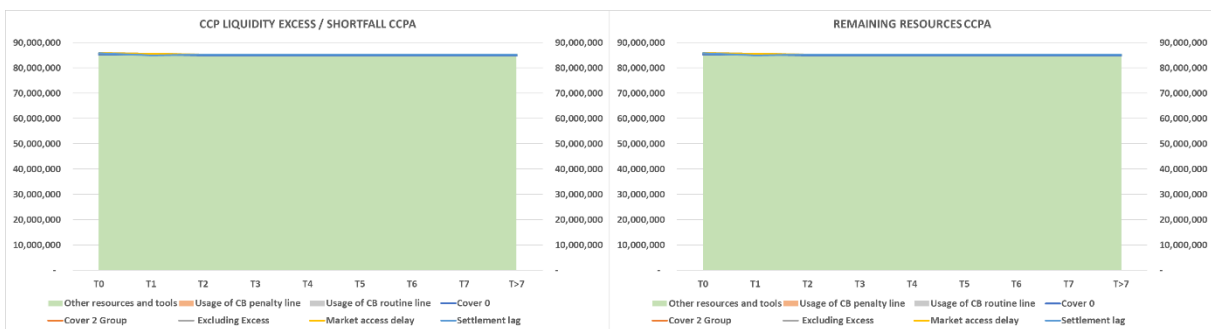


FIGURE 89: DETAILED LIQUIDITY RESULTS FOR CCPA, EU-WIDE COVER-2, EUR-EQUIVALENT

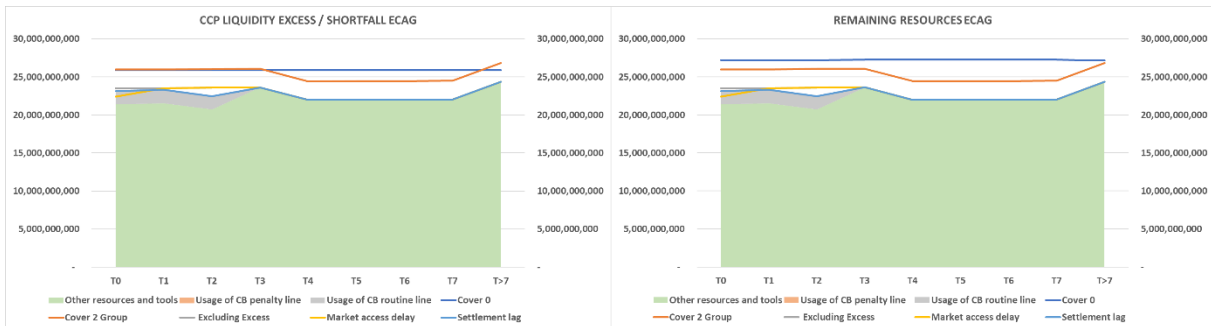


FIGURE 90: DETAILED LIQUIDITY RESULTS FOR ECAG, EU-WIDE COVER-2, EUR-EQUIVALENT

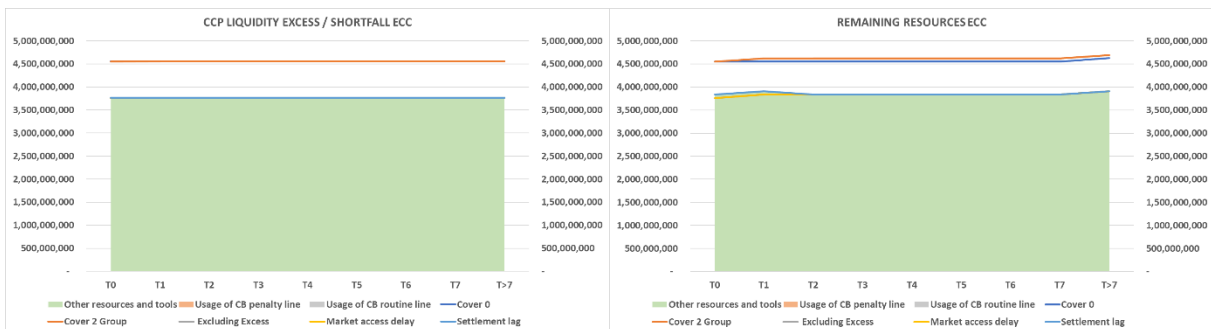


FIGURE 91: DETAILED LIQUIDITY RESULTS FOR ECC, EU-WIDE COVER-2, EUR-EQUIVALENT

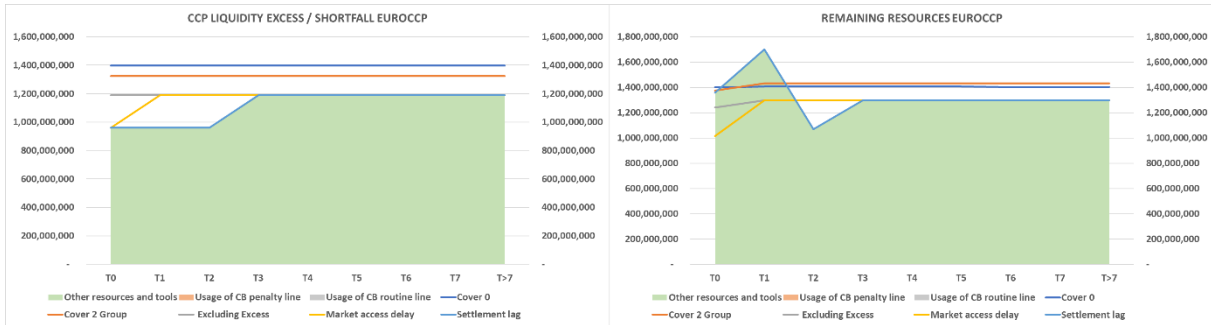


FIGURE 92: DETAILED LIQUIDITY RESULTS FOR EUROCCP, EU-WIDE COVER-2, EUR-EQUIVALENT

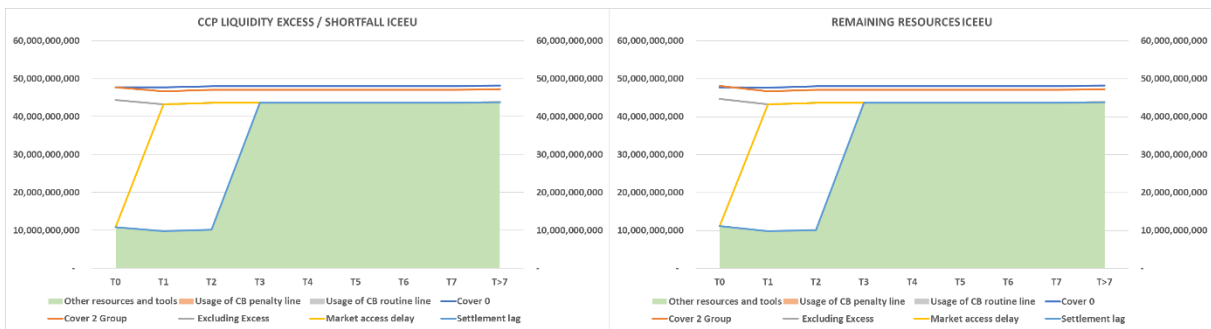


FIGURE 93: DETAILED LIQUIDITY RESULTS FOR ICEEU, EU-WIDE COVER-2, EUR-EQUIVALENT

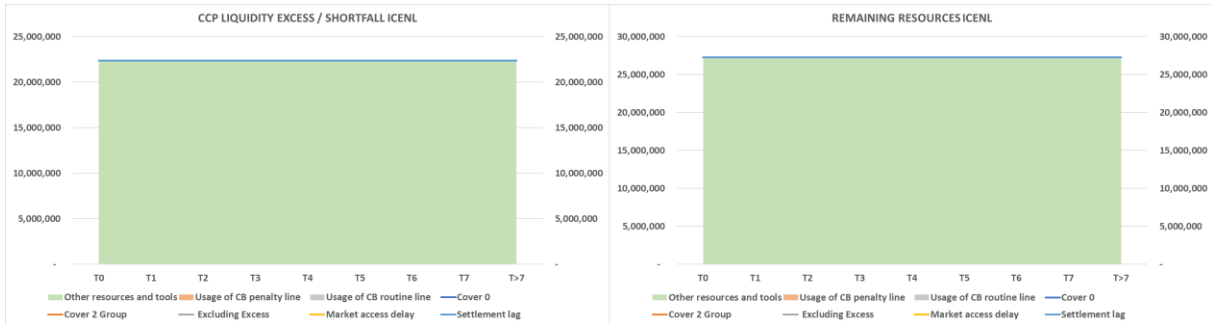


FIGURE 94: DETAILED LIQUIDITY RESULTS FOR ICENL, EU-WIDE COVER-2, EUR-EQUIVALENT

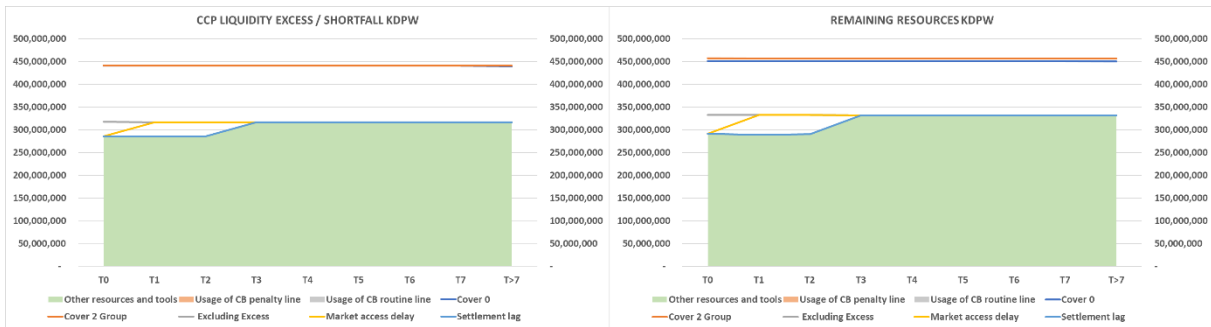


FIGURE 95: DETAILED LIQUIDITY RESULTS FOR KDPW, EU-WIDE COVER-2, EUR-EQUIVALENT

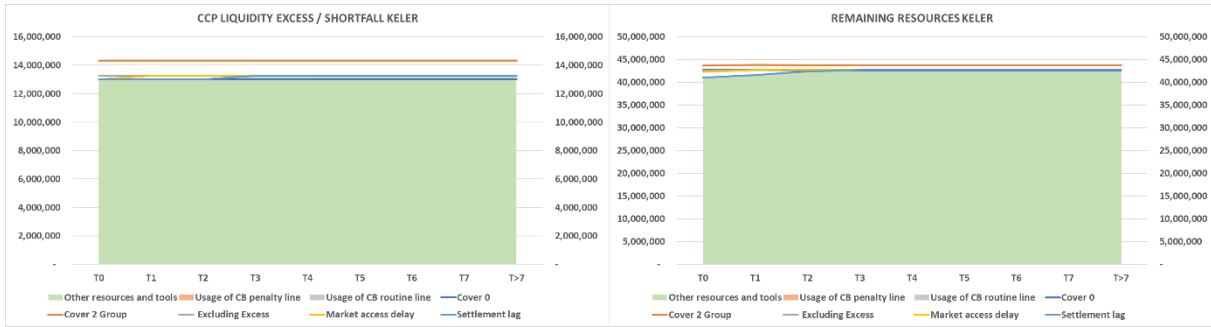


FIGURE 96: DETAILED LIQUIDITY RESULTS FOR KELER, EU-WIDE COVER-2, EUR-EQUIVALENT

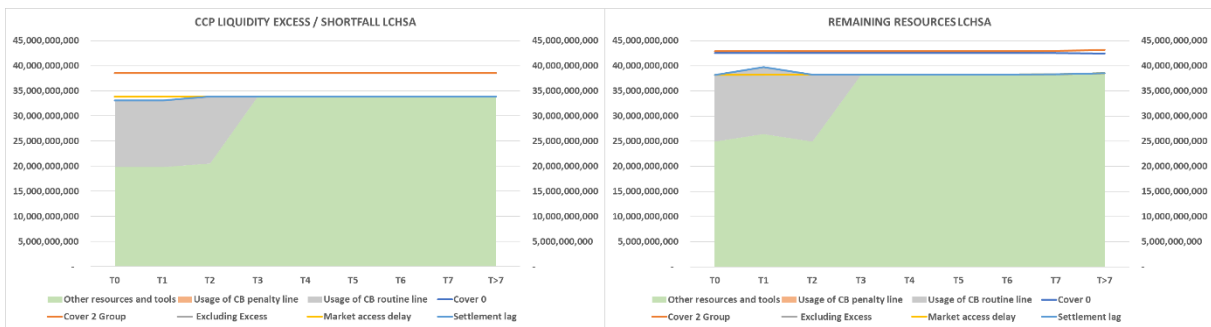


FIGURE 97: DETAILED LIQUIDITY RESULTS FOR LCHSA, EU-WIDE COVER-2, EUR-EQUIVALENT

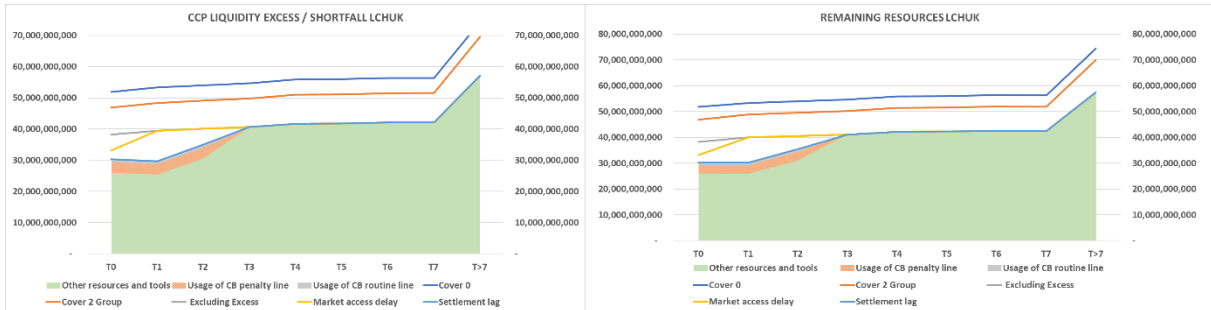


FIGURE 98: DETAILED LIQUIDITY RESULTS FOR LCHUK, EU-WIDE COVER-2, EUR-EQUIVALENT

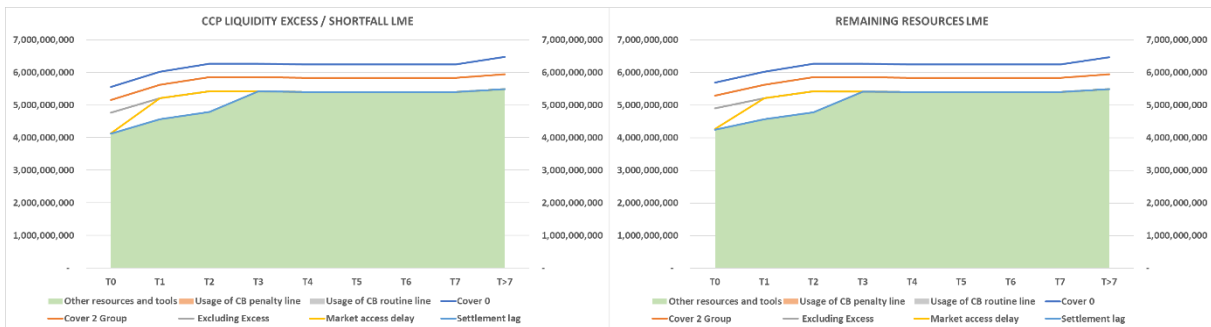


FIGURE 99: DETAILED LIQUIDITY RESULTS FOR LME, EU-WIDE COVER-2, EUR-EQUIVALENT

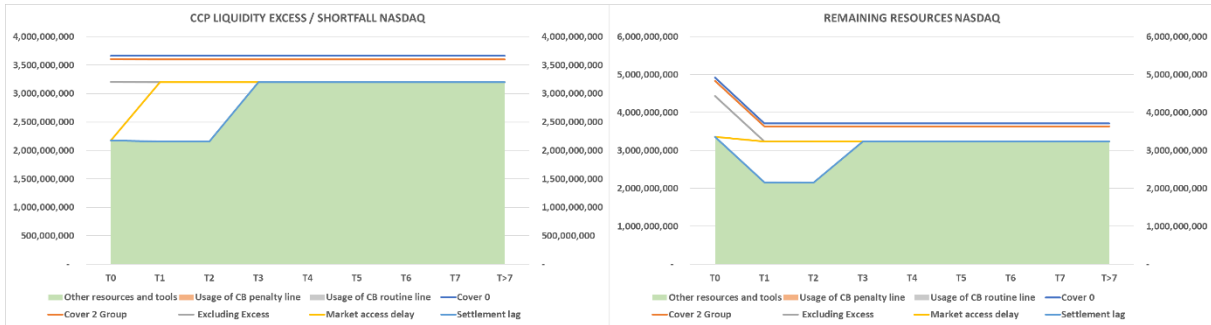


FIGURE 100: DETAILED LIQUIDITY RESULTS FOR NASDAQ, EU-WIDE COVER-2, EUR-EQUIVALENT



FIGURE 101: DETAILED LIQUIDITY RESULTS FOR OMI, EU-WIDE COVER-2, EUR-EQUIVALENT

6.3 Interconnectedness of exposures

6.3.1 Interconnectedness of CCPs through clearing members

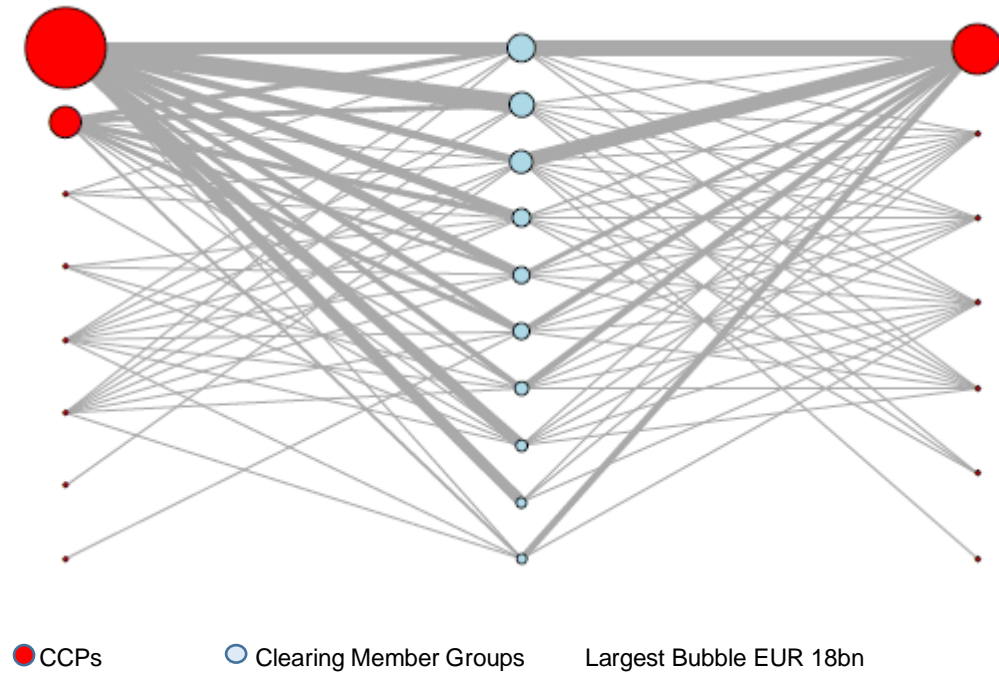
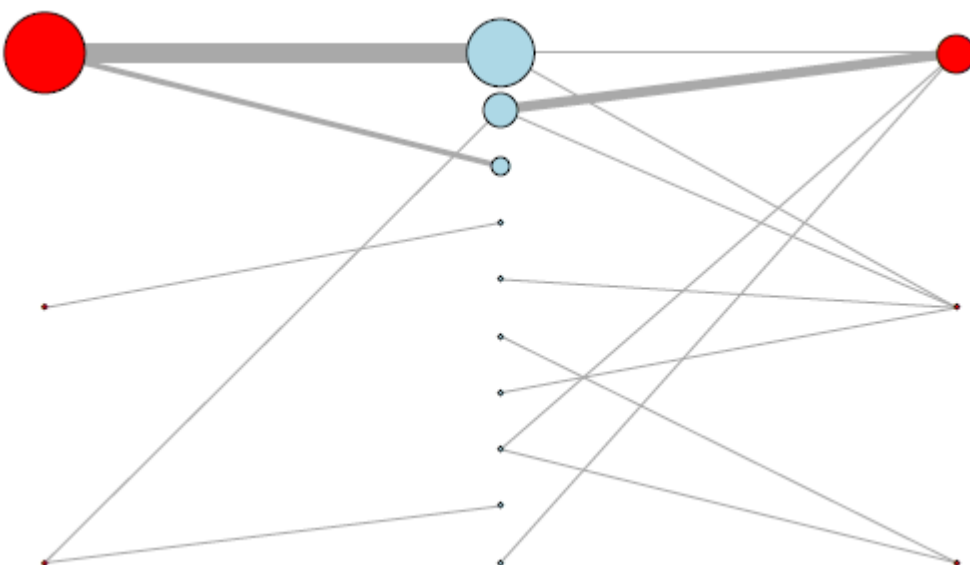


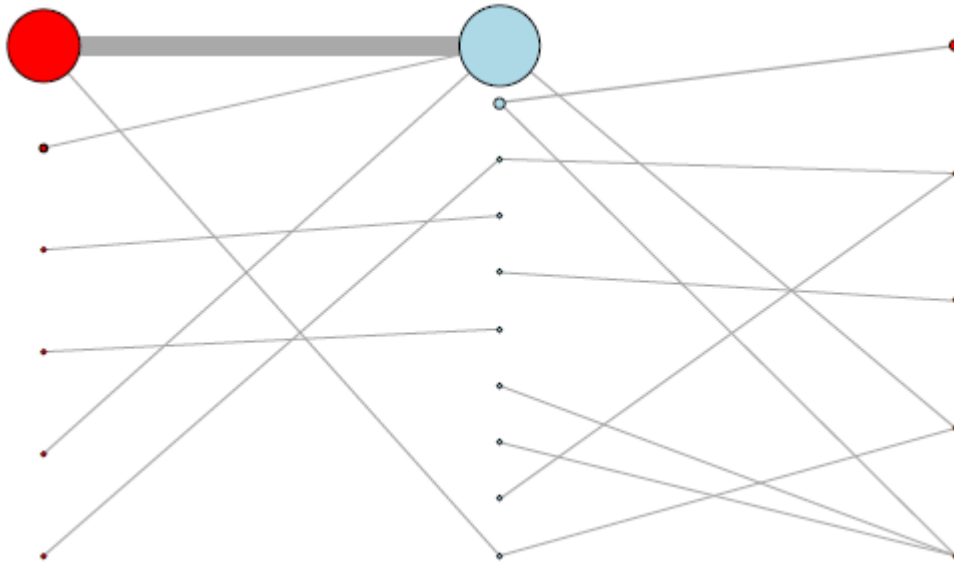
FIGURE 102: NETWORK OF TOP-10 CLEARING MEMBERS BY CONCENTRATION COMPONENT

6.3.2 Interconnectedness of CCPs through custodians



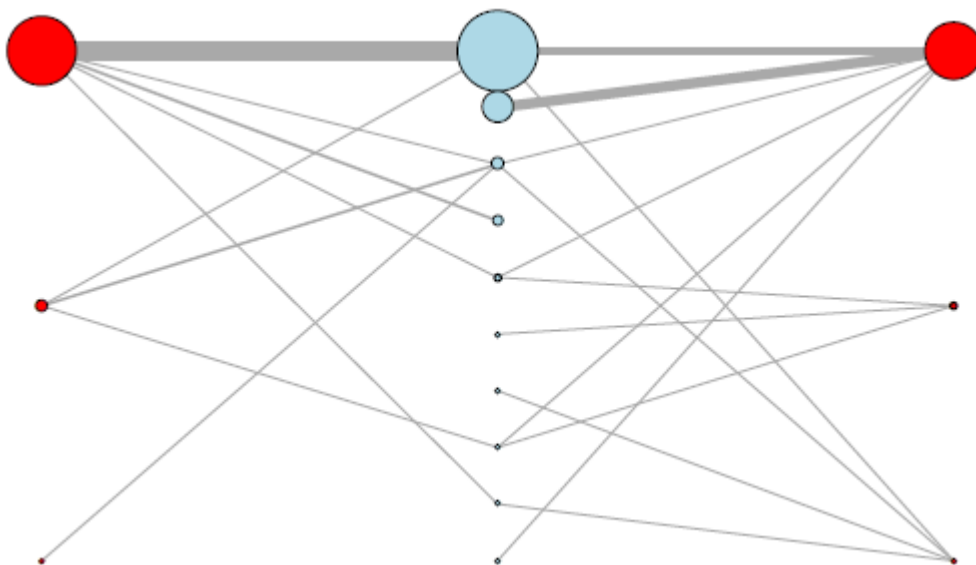
● CCPs ○ Clearing Member Groups Largest Bubble EUR 11bn

FIGURE 103: NETWORK OF TOP-10 CUSTODIANS – CASH ONLY – USD



● CCPs ○ Clearing Member Groups Largest Bubble EUR 5bn

FIGURE 104: NETWORK OF TOP-10 CUSTODIANS – CASH ONLY – EUR



● CCPs ○ Clearing Member Groups Largest Bubble EUR 44bn

FIGURE 105: NETWORK OF TOP-10 CUSTODIANS – CASH AND SECURITIES – USD

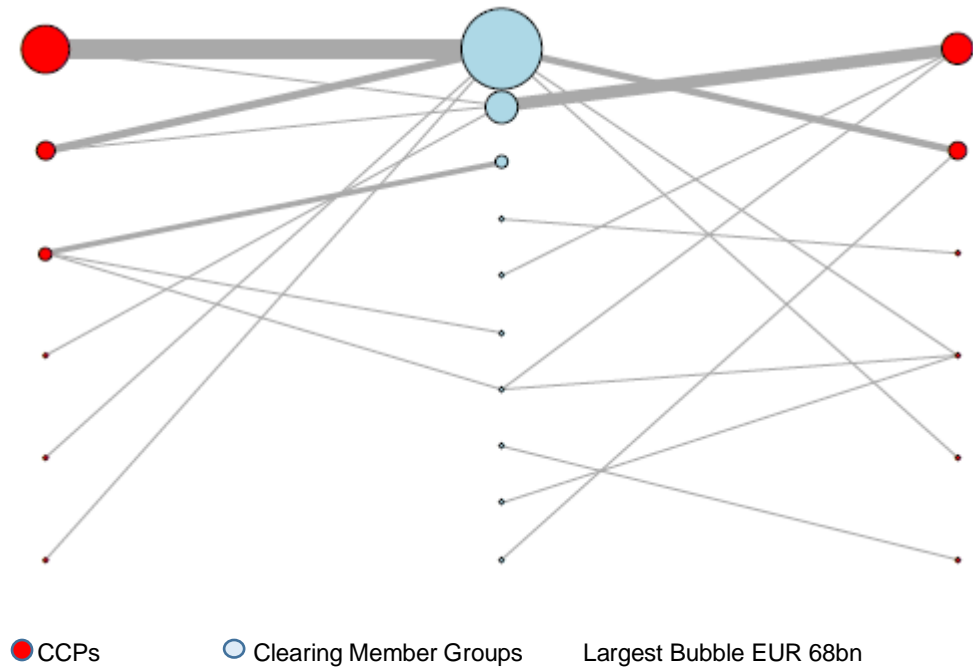


FIGURE 106: NETWORK OF TOP-10 CUSTODIANS – CASH AND SECURITIES – EUR

6.3.3 Interconnectedness of CCPs through liquidity providers

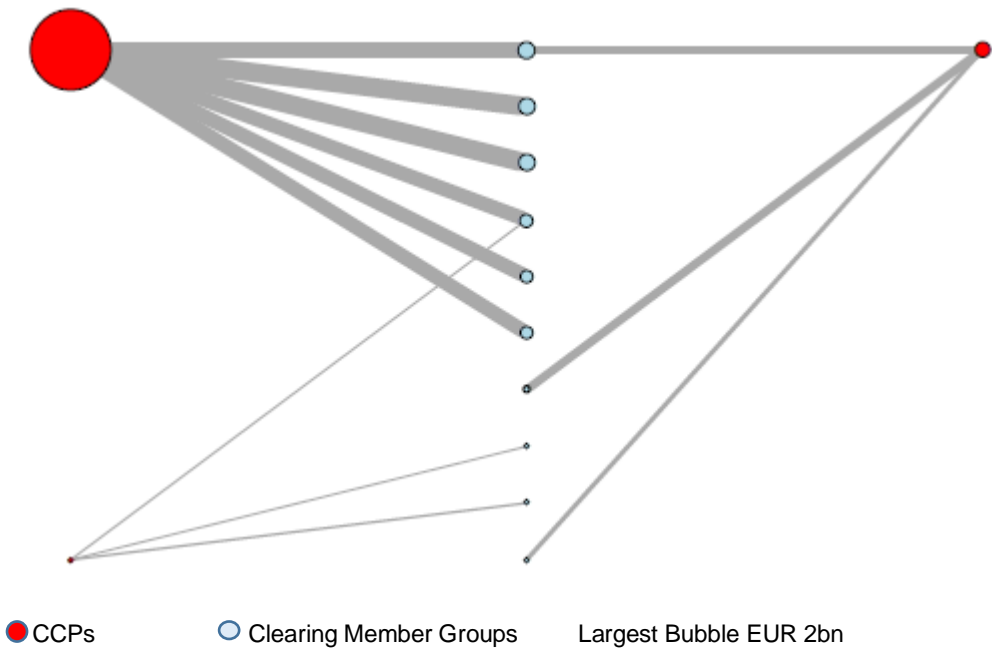


FIGURE 107: NETWORK OF TOP-10 COMMITTED LIQUIDITY LINES – USD

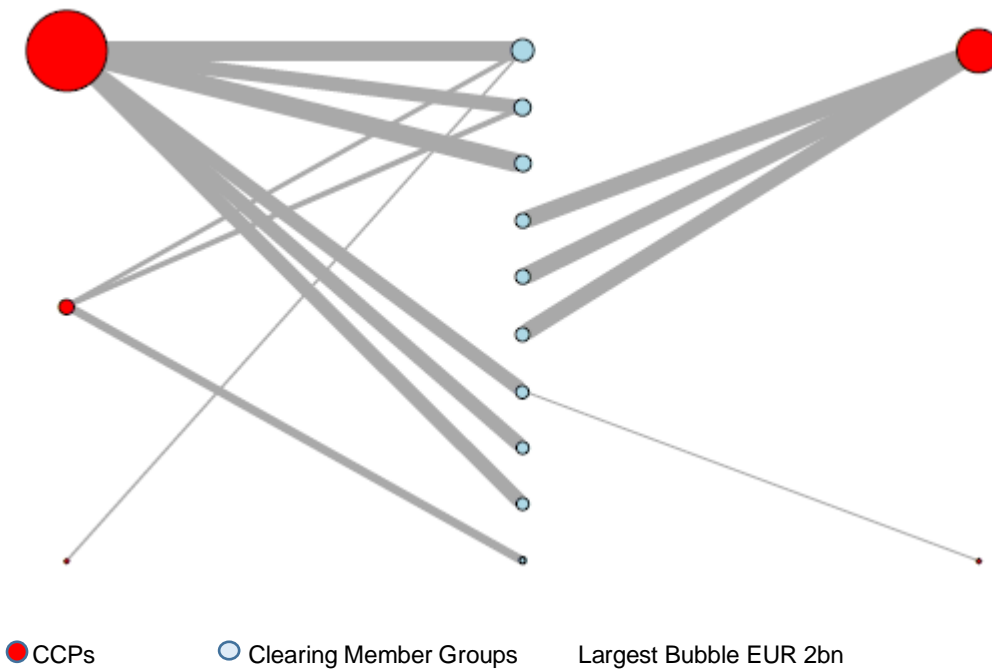


FIGURE 108: NETWORK OF TOP-10 COMMITTED LIQUIDITY LINES – EUR

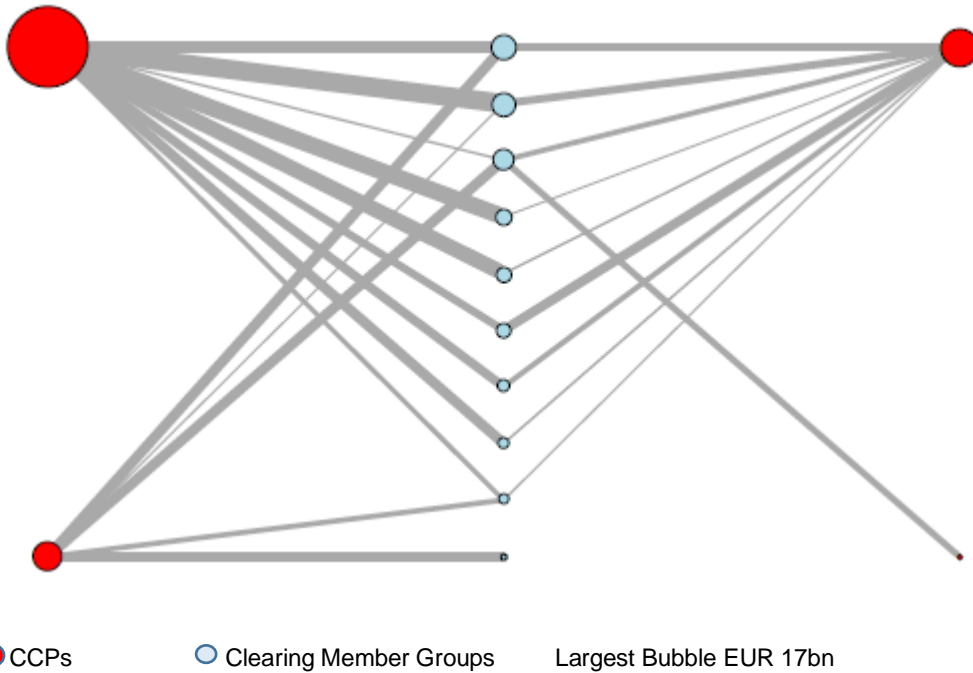


FIGURE 109: NETWORK OF TOP-10 COMMITTED CREDIT LINES AND ALL REPO PROVIDERS (COMMITTED AND UNCOMMITTED) – USD

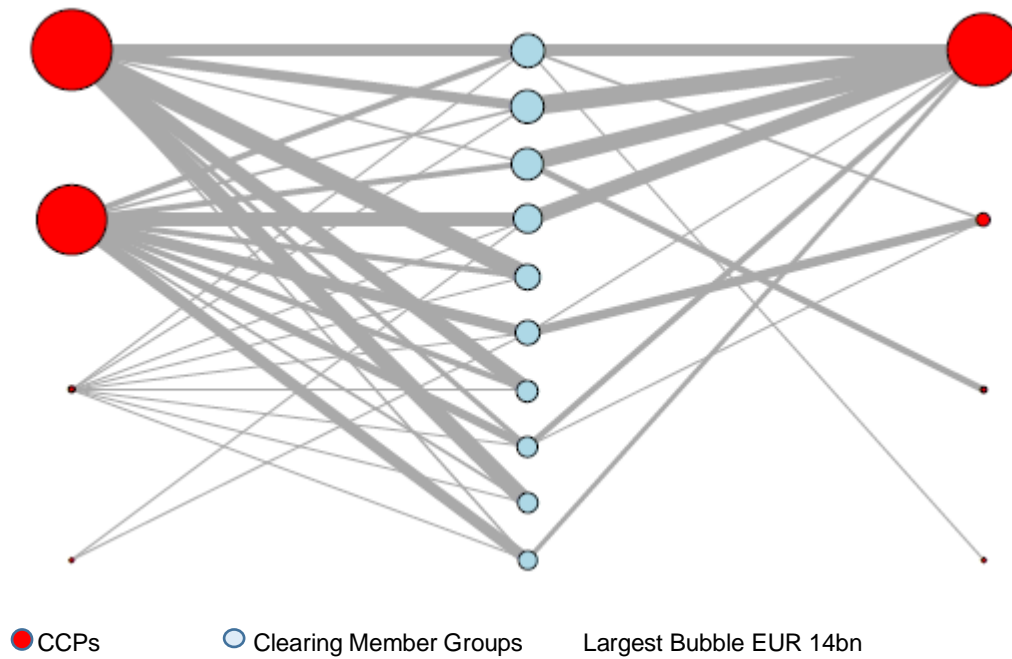


FIGURE 110: NETWORK OF TOP-10 COMMITTED CREDIT LINES AND ALL REPO PROVIDERS (COMMITTED AND UNCOMMITTED) – EUR

6.4 Specific Concentration Methodologies

6.4.1 Credit Derivatives Methodology

459. The concentration risk for credit derivatives is assessed through the market impact cost of setting-up a relevant hedging portfolio. Such hedging is assumed to be done using the 5Y maturity only.

460. This choice had the following consequences:

- Calendar spread positions on the curve are netted and therefore have their cost much reduced.
- The difference in liquidity between different maturities is ignored, and the most liquid point is used.

461. For single names, different restructuring conventions are ignored.

462. CCPs clearing CDSs use more complex models than the approach chosen by the framework.

463. Although the modelling explains well the concentration add-ons of the CCPs (with R2 of 72% and 95%), the market impact computed for each CCP using its own sensitivity table generates only around 10 to 15% of the concentration add-ons it charges.

464. It is therefore difficult to draw conclusions from the results on that asset class.

6.4.2 Fixed Income Derivatives Methodology

465. The concentration risk for fixed income derivatives is assessed through the market impact cost of setting-up a relevant hedging portfolio. The further costs incurred from auctioning the portfolio are not considered.

466. In order to allow the accurate pricing and hedging of swaps, CCPs have reported the position sensitivities to both forecasting and discounting curves on 15 maturity points spanning 1Y to 50Y.

467. In each relevant currency, it is assumed that the main risks can be adequately hedged through hedging the exposures to both the discounting and the forecasting curves on 4 different maturity points (2Y, 5Y, 10Y, 30Y). ESMA staff apportioned the sensitivities to the 4 hedge maturity points on a time basis.

468. Basis swaps between OIS and IBOR were also considered as a possible hedge. The most favourable market impact using one of the 3 possible hedging strategies {forecasting + discounting, forecasting + basis and discounting + basis} was kept.

469. For each pillar, a concentration cost per hedge maturity is computed by using the relevant size through interpolation.

470. A separate market impact for each of the 3 reporting sub-asset classes (Bond futures / forwards, IR futures and FRA and Swaps) is computed.