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Loss absorption capacity of central counterparties. Evidence from EU-authorised CCPs – part II

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Abstract

The aim of this study was to investigate loss absorption capacity of central counterparties. The qualitative and quantitative analysis was based on PQD data provided by 15 EU-authorised CCPs for Q4 2015–Q4 2017. Certain indicators were proposed in order to delineate the empirical structure of CCPs' default waterfalls and to assess the viability and stability of CCPs. The main conclusion of the analysis is that in order to incentivise clearing participants as much as possible towards prudent risk management, the structure of default waterfall should be modified.

Keywords: CCP, central clearing, default waterfall, financial stability, liquidity risk

JEL: G01, G15, G18, G23, L14

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1 Default waterfalls of CCPs authorised in the EU

1.1 Short description of data analysis

The basis for this section is created by CPMI-IOSCO (2015) PQD standards which are not mandatory and rather constitute an example of good practice among central counterparties. Each quarter CCPs publish on their websites quantitative and qualitative data concerning such data as their default waterfalls, cleared transactions, structure, etc. As of 2019, the PQD remains the only source of publicly available data provided by CCPs. Despite no direct link between the PQD and the EMIR regime and thus, conceptual discrepancies, the PQD constitutes a valuable source of information about central clearing environment in the EU. It is also worth noticing that due to the non-obligatory character of disclosure, despite common templates worked out by CCPs' associations, CCPs tend to submit their data in different ways, which results in the varying quality of provided data.[1] The data were gathered on cut--off dates at the end of each quarter for Q4 2015–Q4 2017.

Table 1 in the Appendix contains further information about entities whose DWs were analysed and the time horizon that was taken into account. It includes all EU-authorised CCPs except from the Greece-based Athex Exchange Clearing House, which does not provide quantitative data based on PQD standards. For four CCPs the calculations do not cover the entire period as three CCPs started to submit their data in 2016 (CCP Austria, Keler CCP and European Commodity Clearing) and one CCP, i.e. the ICE Clear Netherlands, in Q2 2017 moved all its registered positions to the LCH Group.

The calculation was conducted for both segments of derivative contracts: the ETD and the OTC, as well as for cash instruments. However, the latter were included by CCPs in the ETD segment. Due to the granularity level of the data, splitting the segments was impossible. What is more, CCPs usually submitted data in local currencies which were converted into euro on the basis of exchange rates provided by the European Central Bank for particular cut-off dates. As interoperability arrangements are not the subject of this paper and require further discussion they were not included in the calculations.[2]

1.2 Percentage structure of resources

The structure of the default waterfall was derived from EMIR. In addition, corresponding individual variables were chosen on the basis of the PQD matrix so as to reflect the reality and economics of central clearing environment to the greatest extent possible. The formulae for calculating the percentage share of each layer in the DW for an individual CCP are presented in Table 2 in the Appendix. A cautious approach was applied in the computation in order to reflect the minimum required share for each level. It means that the amount of the initial margin required was used rather than the post-haircut

[1] For example, the major inconvenience connected with data quality is that one CCP reports its numerical data in PDF whereas all other CCPs submit it in Excel files. It is also worth noticing that some CCPs gather data for 4 quarters in one file, which unfortunately does not contain all records for all quarters. The other problem that occurred during preparation of this paper was that after publishing the data for the most recent quarter, some CCPs have withdrawn the data for older quarters from their websites.

[2] In the examined period only four EU-authorised CCPs discussed in this paper had their interoperability arrangements in use (LCH. Clearnet Ltd., LCH. Clearnet SA., European CCP, CCG). For further details, please consult ESMA (2016a).

initial margin held. To provide further consistency in computations, also the minimum required default fund contributions were taken instead of post-haircut contributions. Resources provided by CCPs participating in the interoperability arrangements concerning the default waterfalls of their counterparties were not taken into account.

As a result, the simplified structure for Q4 2015–Q4 2017, which was based on the proposed formulae, is presented in Table 3 in the Appendix. The results show that CCPs tend to burden other central clearing participants with the costs of participating in the default waterfall mechanism. What is more, the initial margin constitutes a major share in the contribution of CMs and NCMs. However, due to the fact that EMIR forbids using the initial margin provided by non-defaulting CMs in default management procedures and given the fact that the initial margin remains the largest layer in the DW, the loss-absorption capacity of CCPs is much lower than presented. The detailed structure of default waterfalls for each quarter is presented in Tables 4–12 in the Appendix.

The initial margin was calculated by aggregating the house-net, client-gross and client-net margin.[3] The required initial margin in most cases constitutes more than 50% of the DW. When considering the post-haircut initial margin held, the share is even higher. For five CCPs in all the examined quarters (CCP Austria, European CCP, CCG, OMI Clear, KDPW_CCP, Keler CCP) the share of the required initial margin is worryingly low. In all the examined quarters the lowest share of the required IM is reported by CCP Austria, however, this CCP also reported a relatively high level of the pre-haircut held IM and the post-haircut held IM. A clear evidence of this is given by the overmargining ratio that is discussed later in this paper. When it comes to the European CCP and CCG, a low share of the IM may result from the exclusion from the calculations of resources provided by other CCPs via interoperability arrangements. In the case of OMI Clear, the reason for such a low share of the required IM may be the class of contract, which consists of power derivatives and whose parameters actually determine the level of the IM. Only the reason for such a low share of the required IM in KDPW_CCP and in Keler CCP remains unclear.

The prefunded contribution to the default fund was derived as a sum of required prefunded aggregate participant contributions and other contributions. Since those descriptions sound rather cryptic, a further analysis of explanatory notes in the PQD was needed. According to the CPMI-IOSCO (2015) PQD standards, a default fund should cover losses that exceed the initial margin of a defaulting CM. However, the whole Principle 4, which comes from the CPSS-IOSCO (2012) PFMIs and which touches on credit risk, makes CCPs provide data for the total value of default resources excluding the IM and the VM, which combine prefunded and non-prefunded contributions as well as the SITG and the CCP's remaining capital. Therefore, it was assumed that prefunded contributions reflect 4.1 (a)(ii-iii) from the PQD matrix, whereas non-prefunded contributions are equivalent to committed resources outlined in 4.1 (b)(ii-iii).

Generally, default fund contributions are significantly lower than initial margins. The proportions between prefunded and non-prefunded resources vary significantly and there is no unanimous trend in this regard. However, such a high level of non-prefunded resources remains worrisome in nearly half of the examined CCPs in the whole period.

The SITG was, in turn, described as DF_{CCP} that forms a contribution of a CCP to the DF. It is also equivalent to the 4.1 (a)(i) from the PQD matrix, which is specified as the CCP's own capital

[3] Client-gross margin means that it must be provided for each indirect participant's own position whereas client-net margin must be provided for the net position of clients. The house-net margin is provided by CMs.

that forms a prefunded contribution which can be used before and alongside member contributions. The CCP's remaining capital is specified as a prefunded contribution 'after' and as committed resources that address a participant's default and which are equivalent to 4.1 (b)(1) from the PQD matrix. It is worth noticing that in half of the examined CCPs the share of the remaining capital is close to 0%. The level of the SITG is slightly higher, yet it oscillates around 0% and remains at a worryingly low level. As both layers have the lowest share, they have limited capacity of loss absorption and a rather nominal than real function. On the other hand, one CCP, i.e. KDPW_CCP, has the highest ratio of the SITG in the DW resources, which in some quarters even exceeds 10%, a figure which raises doubts whether KDPW_CCP's members are incentivised enough to manage risk properly.

1.3 Overcollateralisation

The EMIR regime does not impose an obligation to provide CCPs with more resources than required. However, data show that CCPs tend to collect more collateral in the case of initial margins and default fund contributions than required, which intuitively means that overcollateralisation, defined as a surplus over required resources, may be a common phenomenon in central clearing environment. However, in order to confirm such presumptions and to show different policies of CCPs in this field, particularly with regard to both the level of the IM and DF contributions, the following ratios were proposed and calculated:

a) overmargining ratio,

b) overcollateralisation of the DF ratio,

c) total overcollateralisation ratio.

Overmargining ratio shows how many times the amount of post-haircut initial margin held is larger than the required amount. The required IM means the minimum level of resources that have to be provided to the CCP, whereas post-haircut initial margin held refers to the resources literally kept by the CCP, including the imposed haircut. A similar ratio was also proposed in Alfranseder et al. (2018). Its main aim is to give a clear indication that CCPs have more resources than required at their disposal and hence, they have higher loss-absorption capacity.

The ratio was calculated using the following formula:

$$overmargining\ ratio = \frac{IM_{posted}}{IM_{req}} \tag{1}$$

where:

IM_{posted} means the post-haircut initial margin held,

IM_{req} means the initial margin required.[4]

The results for each quarter are presented in Table 13 in the Appendix.

Generally, the post-haircut initial margin held exceeds the amount of the required initial margin in most cases. In theory, the biggest the ratio, the better for the CCP since it has a larger DW and loss mutualisation is transferred to CMs. The reason why the post-haircut IM held is higher than the required one is that CMs may provide more resources than needed in order to have enough resources to limit the number of margin calls (Alfranseder et al. 2018). Moreover, Murphy (2017) indicates that

[4] In the PQD matrix the IM required is described as 6.1.1 and the total IM post-haircut held is described as 6.2.15.

CMs provide more margin collateral than required in order to reduce the risk that the DF is used. CCPs, in turn, may prefer a higher IM in order to minimise the probability of depleting the DF and the SITG. However, taking into account all incentives that were described at length in the previous section and given the nature of the initial margin, which more or less entails freezing highly liquid assets, it is better for CMs to bring as much funds as needed, not more, but still not less than required. Therefore, the closer the ratio is to one (but not less), the better. The proportion is important insofar as too high an initial margin may deter CMs from concluding contracts and in the long term impact the liquidity of the OTC derivatives market adversely. For some quarters only in the case of LCH Clearnet S.A. and the CCG the ratio did not exceed 1. The main reason for this result may lie in the exclusion of resources provided in interoperability arrangements. However, it is worth noticing that in the case of LCH Clearnet S.A. the total overcollateralisation ratio (which is described further in this subsection) in the examined period never falls below 1, whereas for the CCG between Q2 2017 and Q4 2017 it remains below 1. This may imply that the CCG relies largely on the resources provided via the interoperability arrangement.

A further look into overcollateralisation is given by the next ratio, which was constructed in the analogous way to the previous one. This ratio makes it possible to compare the prefunded contribution to the DF as required to the post-haircut posted one. Pre-funded contributions required refer to DF contributions required to be posted *ex ante* to the CCPs. Post-haircut prefunded contributions posted by analogy mean resources literally collected by CCPs, which also include the haircut policy applied by CCPs. Therefore, the ratio was derived from the following formula:

$$overcollateralisation\ of\ DF\ ratio = \frac{DF_{posted}}{DF_{req}} \tag{2}$$

where:

DF_{posted} means post-haircut posted prefunded contributions,

DF_{req} means required prefunded contributions.[5]

The results for each quarter are provided in Table 14 in the Appendix.

The post-haircut prefunded contributions to the DF posted in the examined period in nearly half of the discussed CCPs do not exceed the required amount. In some cases the ratio slightly surpasses 1. The ratio does not vary significantly, which means that CCPs tend to pose a similar additional burden on CMs across the board. As the functions of the default fund differ from those of the initial margin, the higher the ratio the better. Its level may also be justified by the fact that all CMs participate in the DF in a proportionate manner and hence, they are highly incentivised to avoid any defaults.

The last ratio proposed in this subsection, i.e. the total overcollateralisation ratio, aims at showing the combined effect of total overcollateralisation and includes resources provided within the IM and DF contributions. In its construction the variables used for the calculation of both overmargining and overcollateralisation ratios were used. The total overcollateralisation ratio makes it possible to assess if and if so, how much overcollateralisation is common for central clearing participants.

In the nominator post-haircut resources held were used, whereas the denominator was determined by the required resources. Therefore, the formula looks as follows:

[5] In the PQD matrix the DF required is described as 4.1.4 and the DF post-haircut posted is described as 4.1.5. Other contributions denoted as 4.1.6 were not included in the calculations.

$$total\ overcollateralisation\ ratio = \frac{IM_{posted} + DF_{posted}}{IM_{req} + DF_{req}} \tag{3}$$

The results of the calculation are presented in Table 15 in the Appendix.

The ratio gives clear indication that CMs prefer to provide more resources than required. This tendency is mostly visible in the case of Keler CCP and CCP Austria. Only in one case, i.e. the CCG, as mentioned before, the overcollateralisation ratio for Q2 2017–Q4 2017 was astonishingly low and remained below the required level.

It is worth noticing that splitting the overcollateralisation into the overmargining and overcollateralisation ratios makes it possible to determine which DW layer contributes to a greater extent to increasing the level of the DW and hence, to higher loss absorption capacity of the DW. Such a distribution is important insofar as the purposes of both the IM and the DF differ. The results for all ratios indicate that it is the IM which is the layer which predominantly contributes to overcollateralisation.

1.4 Default resources in relation to CMs' exposures

The above presented ratios do not fully cover and explain the loss absorption capacity of the default waterfalls of particular CCPs. To do so, it is essential to compare some layers of the default waterfall with CCPs' exposures to the CMs. Under EMIR the default fund and the SITG should be sufficient to cover losses stemming from exposures to at least two largest CMs in extreme but plausible market conditions. In practice, the default fund and the SITG are known as Cover 2, which means they should be sufficient to cover losses that may come from the two largest CMs.[6]

In order to provide further insight into the loss absorption capacity of CCPs, the following indicators are proposed:

a) mean average indicator,

b) peak indicator.

The mean average indicator aims at showing whether the CCP is able to withstand average losses exceeding the initial margin of defaulting counterparties that come from the two largest clearing members and arise in extreme but plausible market conditions. Hence, Cover 2, i.e. the required DF contributions and the SITG, was proposed in the numerator. The initial margin was not included in the calculations as EMIR forbids using the IM of non-defaulting CMs in default management procedures. Including it would make it impossible to reflect the loss absorption capacity of the DW properly. The denominator, in turn, consists in the estimated mean average credit exposure to the two largest CMs over the previous twelve months. Such a variable represents the potential mean losses that may arise should the two largest CMs default and was applied in the calculations in order to reflect the main assumptions about the loss absorption capacity of CCPs stated in EMIR.

Hence, the formula for the indicator is the following:

$$mean\ average\ indicator = \frac{DF_{req} + SITG}{|exposure_{mean}|} \tag{4}$$

[6] For further information concerning the concept of Cover k charge, see Lin and Surti (2015).

where $exposure_{mean}$ means the estimated mean average exposure to the two largest CMs over the previous twelve months.[7]

The results of the calculation are presented in Table 16 in the Appendix.

The ratio shows the relation between the sum of prefunded resources and average losses which occurred over the previous twelve months and which came from the two largest CMs. Certainly the higher the indicator the better. Considering the fact that this indicator makes it possible to compare the state of default resources at the end of a given quarter with the mean average over the previous twelve months, our ability to derive conclusions may be limited. Moreover, as in its construction certain variables, whose level is foreseen in EMIR, were used, it seems natural that the indicator should exceed at least 1. However, the ratio still creates an intuitive measure which makes it possible to compile both layers of the DWs with CCPs' credit exposures and gives a general picture of the proportions between them. In the case of nearly all the CCPs the results show that the required DF contributions and the SITG would be sufficient to withstand average losses stemming from the default of the two largest CMs. In some cases, they would cover such losses even several times over. Only in the case of BME Clearing for Q4 2015–Q3 2017 the resources are insufficient.

More severe turbulences are taken into account in the case of the next ratio, which was called peak indicator. It aims at testing CCPs' capacity to withstand peak day losses occurring over the previous twelve months and coming from the two largest CMs. The numerator of the indicator remains the same, whereas for the denominator the estimated peak day amount of credit exposure to the two largest CMs over the previous twelve months was used. This indicator aims at assessing the ability of the CCP to withstand peak losses stemming from the default of the two largest CMs.

The formula for the indicator looks as follows:

$$peak\ indicator = \frac{DF_{req} + SITG}{\left| exposure_{peak} \right|} \tag{5}$$

where $exposure_{peak}$ means the estimated peak day amount of exposure to the two largest CMs over the previous twelve months.[8]

The results of the calculation are shown in Table 17 in the Appendix.

In contrast to the previous ratio, the level of this ratio is not even indirectly foreseen in EMIR. Moreover, the interpretation of this ratio slightly differs from the interpretation of the previous one as the indicator shows how the sum of prefunded contributions and the SITG stands in comparison to peak losses. As in the previous case, the higher the indicator the better. In this situation, the loss absorption capacity of several CCPs in at least one quarter is questionable. These CCPs are: European CCP, Eurex Clearing, European Commodity Clearing, CCP Austria, BME Clearing, OMIClear, and ICE Clear Netherlands. It is interesting that the reduced capacity concerns even large CCPs such as Eurex Clearing and generally differs between particular CCPs. It is also worth noticing that in the case of BME Clearing, which reports the lowest ratios, the results of both indicators remain worrying. Last

[7] The data concerning the mean exposure are specified as 4.4.7 in the PQD matrix and are reported in excess of the IM. The SITG is derived from own calculations. In the calculations the absolute value of exposure was used, as for some quarters two CCPs reported a negative value.

[8] The peak exposure is also denoted as 4.4.7 in the PQD matrix and is reported in excess of the IM.

but not least, the ratio gives a clear indication that the loss absorption capacity of the CCPs is mainly concentrated within losses stemming from the default of the two largest CMs, which means that in the case of extreme market turbulences, CCPs would be forced to call non-defaulting CMs for additional promissory resources.

2 Concluding remarks

The results of the research lead to the conclusion that due to the construction of the default waterfall central counterparties undeniably equip the whole market infrastructure with the toolkit that in extreme but plausible market conditions enforces prudent risk management and hence contributes to systemic risk mitigation.

Moreover, it is worth noticing that the results of the analysis generally resemble those of the EU-wide CCP stress test that was conducted by ESMA in 2015. According to the report based on the stress test, the whole system can be regarded as resilient to the assumed stress scenarios, which were rather extreme and unlike. In addition, the stress test verified that within the whole system the probability of contagion remains low. The conclusions of this stress test, however, do not apply to the condition of individual CCPs (ESMA 2016b).[9] The results of the second EU-wide CCP stress test, conducted in 2017 by ESMA, also proved the resilience of the whole system. Similarly to the results of the present analysis, the stress test showed that only one CCP, i.e. BME Clearing, would have to provide additional non-prefunded resources should multiple defaults occur. However, ESMA indicates that this shortfall is considered to be marginal and without systemic impact. Also the results of the liquidity stress test confirmed the viability of the system, albeit it was emphasised that CCPs use different tools to meet their liquidity demand such as access to short-term FX markets and central bank repo lines (ESMA 2018).

As mentioned in the previous sections, the loss absorption capacity of CCPs depends strictly on CCPs' default management procedures and the structure of the default waterfall, which should be designed so as to provide maximum incentives for prudent risk management for both the CMs and the CCP.

The incentives play a key role in the whole mechanism since the purpose of each participant is to bear as low costs as possible. To achieve this, the chances of default of any counterparty should be minimised. Should any counterparty default, CMs would likely be willing to participate in auctions and to provide competitive bids in order to avoid depleting default waterfall resources, a painful outcome for all the participants. In other words, due to the construction of the default waterfall and mostly because of the desire to minimise additional costs, it is in everybody's interest to manage positions conservatively. In addition, the default waterfall can be regarded as an insurance policy since actually only in the case of a default that is somehow connected with the negligence of the counterparties, the resources of counterparties are used. However, one should bear in mind that the efficiency of incentives is strictly connected with the willingness of CMs to minimise costs. Should willingness be lacking, the resilience of CCPs becomes questionable. Therefore, the optimum structure of the DW should be designed so as to take the incentives into consideration to the greatest extent possible.

[9] In spite of that ESMA indicated that CCPs tend to apply less conservative stress tests than those conducted by ESMA.

As shown in Tables 3–12 the percentage structure of the DW varies across CCPs but has common features as well, such as the largest contribution to the default waterfall which is provided by the clearing members and the lowest one guaranteed by CCPs. In this connection, it is worth noticing that in almost all cases the IM constitutes the most significant share of the DW. Since EMIR forbids using the IM of a non-defaulting CM, the loss absorption capacity is therefore naturally limited. DF contributions, in turn, create a significantly thinner DW layer. In the case of both layers, as shown by the three overcollateralisation ratios (Tables 13–15), CMs tend to provide CCPs with additional *ex ante* posted resources that due to their high liquidity contribute positively to the viability of CCPs. However, it remains worrisome that in the structure of the DW in some CCPs there is a relatively high share of non-prefunded resources and a very low share of the SITG and CCPs' own capital, the latter amounting to 0% in many cases.

The proposed mean and peak ratios (Tables 16–17) proved that almost all EU-authorised CCPs meet the requirements of loss absorption capacity stated in EMIR and should extreme but plausible market conditions occur, they would withstand losses stemming from defaults of two CMs to which they have the largest exposures. In addition, in many cases this capacity exceeded the requirements several times over. However, given the fact that such conditions are rather unlikely, default waterfalls seem to guarantee the systemic resilience of all central counterparties across the EU efficiently. On the other hand, significant differences between the results for mean and peak ratios make it clear that CCPs' loss-absorption capacity is mainly concentrated within losses stemming from exposures to the top two CMs. Should more defaults occur, CCPs would be forced to deplete their own resources, which, given the fact that the contribution of CCP capital to the DW in almost all cases is too low, remains questionable.

It is also worth mentioning that as the significant share of the default waterfall consists of non-prefunded layers, relying on them may expose CCPs and CMs to liquidity problems, which simply put means a shift from credit counterparty risk to liquidity risk. What is more, such a structure of the DW is far from optimal as it does not provide proper incentives for CCPs and CMs towards prudent risk management. Definitely, the level of non-prefunded resources should be limited given the fact that they are presumed to be used in extreme market conditions. When considering this problem one should bear in mind that the obligatory central clearing environment was created in the aftermath of the latest financial crisis. Generally speaking, it should contribute positively to financial market stability. Therefore, the need to address such a problem is crucial insofar as a liquidity shortage may occur in the case of severe market conditions, which mean extreme market volatility. At that time, it might be difficult to provide any liquidity in the shortest time possible. Therefore, in order to avoid aggravating the negative consequences of market shocks, it is crucial to limit the share of non-prefunded resources and provide both CMs and CCPs with access to emergency liquidity, although on conditions that minimise moral hazard.

Hence, it is necessary to introduce harmonised law giving the CCPs rights to access emergency liquidity provided by central banks which would act as lenders of last resort. Not all EU-authorised CCPs have such rights.[10] However, this kind of liquidity is safe and offers relatively quick access, and all CCPs should have the possibility to incur intra-day loans on reasonable conditions that would help dealing with liquidity shortages. At the same time, in order to avoid moral hazard the access to central bank liquidity should involve some deterrent conditions, which may, for example, take the form of additional costs imposed on a CCP after it deals with the liquidity shortage.

[10] Some CCPs are partially state-owned which means that providing emergency liquidity by the central bank is regarded as public aid, which is forbidden in accordance with Article 123 of the Treaty on the Functioning of the European Union.

Taking into consideration all of the above, developing a uniform framework on CCP-RR is highly necessary. For the purpose of increasing efficiency and to incentivise participants as much as possible, the structure of the default waterfall should be slightly modified. The share of non-prefunded resources should be limited since they have a promissory character and relying on them may expose CCPs and non-defaulting CMs to further risk, among which the most significant is liquidity shortage. In addition, the conducted analysis of the structure of the DW has shown that CCPs tend to keep too low capital levels compared with resources provided by their CMs, which in the case of the systemic importance of the CCPs remains worrying. Therefore, the capacity of the last layer of the DW should certainly be increased by obliging CCPs to augment their contributions. The level of resources provided by CCPs should preferably be dependent on the clearing activity in order to reflect the economics of central clearing and to ensure incentives towards proper risk management and the proportionality of default waterfalls.

References

Alfranseder E., Fiedor P., Lapschies S., Orszaghova L., Sobolewski P. (2018), *Indicators for the monitoring of central counterparties in the EU,* Occasional Paper Series, 14, March, European Systemic Risk Board.

CPSS, IOSCO (2012), *Principles for financial market infrastructures*, April, Committee on Payment and Settlement Systems, International Organization of Securities Commissions.

CPMI, IOSCO (2015), *Public quantitative disclosure standards for central counterparties,* February, Committee on Payments and Market Infrastructures, International Organization of Securities Commissions.

ESMA (2016a), *Final report. Possible systemic risk and cost implications of interoperability arrangements,* 1 March, European Securities and Markets Authority.

ESMA (2016b), *Report on EU-wide CCP stress test 2015*, 26 April, European Securities and Markets Authority.

ESMA (2018), *Report on EU-wide CCP stress test 2017*, 2 February, European Securities and Markets Authority.

Lin L., Surti J. (2015), Capital requirements for over-the-counter derivatives central counterparties, *Journal of Banking and Finance*, 52, 140–155.

Murphy D. (2017), I've got you under my skin: large central counterparty financial resources and the incentives they create, *Journal of Financial Market Infrastructures,* 5(3), 57–74.

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Appendix

Table 1
List of analysed CCPs

Name of the CCP	Country of establishment	Time horizon of collected data
Nasdaq OMX Clearing AB	Sweden	Q4 2015–Q4 2017
European Central Counterparty N.V.	Netherlands	Q4 2015–Q4 2017
KDPW_CCP	Poland	Q4 2015–Q4 2017
Eurex Clearing AG	Germany	Q4 2015–Q4 2017
Cassa di Compensazione e Garanzia S.p.A. (CCG)	Italy	Q4 2015–Q4 2017
LCH Clearnet SA	France	Q4 2015–Q4 2017
LCH Clearnet Ltd	United Kingdom	Q4 2015–Q4 2017
European Commodity Clearing (ECC)	Germany	Q3 2016–Q4 2017
Keler CCP	Hungary	Q2 2016–Q4 2017
CCP Austria GmbH	Austria	Q1 2016–Q4 2017
LME Clear Ltd	United Kingdom	Q4 2015–Q4 2017
BME Clearing	Spain	Q4 2015–Q4 2017
OMIClear S.A.	Portugal	Q4 2015–Q4 2017
ICE Clear Netherlands B.V.	Netherlands	Q4 2015–Q1 2017
ICE Clear Europe Limited	United Kingdom	Q4 2015–Q4 2017

Source: ESMA, own study.

Table 2
Default waterfall structure based on PQD

Layer of default waterfall	Components	Description
Initial margin	6.1.1	Total required initial margin
Prefunded default fund	4.1.4 + 4.1.6	Sum of aggregate required and other CMs' contributions excluding initial and variation margins
Non-prefunded default fund	4.1.9 + 4.1.10	Sum of additional commitments of CMs
SITG	4.1.1 + 4.1.2	CCP capital that is used within the DW but is limited and potentially covers multiple services with separate segregated DFs
CCP's remaining capital	4.1.3 + 4.1.7	Unlimited commitment of the CCP

Note: the numbers that stand for components are taken from the matrix provided in the PQD and from data files provided by CCPs outlined in Table 1.

Source: CPMI-IOSCO (2015), own study.

Table 3
Tentative structure of default resources (in %)

CCP	Resources provided by	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017
Nasdaq OMX Clearing AB	CCP	2.03	1.39	1.54	2.21	1.70	1.30	1.23	1.16	1.18
	CMs and NCMs	97.97	98.61	98.46	97.79	98.30	98.70	98.77	98.84	98.82
European Central Counterparty N.V.	CCP	0.35	0.30	0.25	0.33	0.53	0.33	0.30	0.32	0.38
	CMs and NCMs	99.65	99.70	99.75	99.67	99.47	99.67	99.70	99.68	99.62
KDPW_CCP	CCP	12.14	11.32	12.41	9.53	8.82	10.65	14.03	14.83	13.57
	CMs and NCMs	87.86	88.68	87.59	90.47	91.18	89.35	85.97	85.17	86.43
Eurex Clearing AG	CCP	1.35	1.41	1.38	1.55	1.53	1.33	1.47	1.53	1.54
	CMs and NCMs	98.65	98.59	98.62	98.45	98.47	98.67	98.53	98.47	98.46
Cassa di Compensazione e Garanzia S.p.A. (CCG)	CCP	0.17	0.13	0.12	0.16	0.16	0.17	0.16	0.22	0.19
	CMs and NCMs	99.83	99.87	99.88	99.84	99.84	99.83	99.84	99.78	99.81
LCH Clearnet SA	CCP	0.17	0.15	0.14	0.17	0.15	0.14	0.15	0.14	0.13
	CMs and NCMs	99.83	99.85	99.86	99.83	99.85	99.86	99.85	99.86	99.87
LCH Clearnet Ltd	CCP	0.08	0.08	0.07	0.06	0.06	0.05	0.05	0.05	0.05
	CMs and NCMs	99.92	99.92	99.93	99.94	99.94	99.95	99.95	99.95	99.95
European Commodity Clearing (ECC)	CCP	n/a	n/a	n/a	9.23	0.24	0.41	0.43	0.43	0.39
	CMs and NCMs	n/a	n/a	n/a	90.77	99.76	99.59	99.57	99.57	99.61
Keler CCP	CCP	n/a	n/a	12.04	11.08	11.06	10.44	5.04	4.58	5.58
	CMs and NCMs	n/a	n/a	87.96	88.92	88.94	89.56	94.96	95.42	94.42
CCP Austria GmbH	CCP	n/a	2.76	2.37	2.13	2.67	2.18	1.42	1.57	2.22
	CMs and NCMs	n/a	97.24	97.63	97.87	97.33	97.82	98.58	98.43	97.78
LME Clear Ltd	CCP	0.44	0.42	0.45	0.42	0.37	0.38	0.42	0.37	0.32
	CMs and NCMs	99.56	99.58	99.55	99.58	99.63	99.62	99.58	99.63	99.68
BME Clearing	CCP	0.38	0.34	0.36	0.39	0.50	0.41	0.61	0.55	0.52
	CMs and NCMs	99.62	99.66	99.64	99.61	99.50	99.59	99.39	99.45	99.48
OMIClear S.A.	CCP	10.08	7.23	6.65	1.24	6.70	6.80	6.27	5.84	6.09
	CMs and NCMs	89.92	92.77	93.35	93.33	93.30	93.20	93.73	94.16	93.91
ICE Clear Netherlands B.V.	CCP	6.03	8.13	8.37	9.35	8.85	8.48	n/a	n/a	n/a
	CMs and NCMs	93.97	91.87	91.63	90.65	91.15	91.52	n/a	n/a	n/a
ICE Clear Europe Limited	CCP	0.30	0.58	0.31	0.30	0.30	0.30	0.32	0.33	0.34
	CMs and NCMs	99.70	99.42	99.69	99.70	99.70	99.70	99.68	99.67	99.66

Source: own calculation.

Table 4
Default waterfall percentage structure in Q4 2015 (in %)

CCP	Default waterfall layer				
	initial margin	prefunded resources	non--prefunded resources	SITG	CCP's capital
Nasdaq OMX Clearing AB	79.33	11.14	7.50	0.50	1.53
European Central Counterparty N.V.	37.52	31.06	31.06	0.35	0.00
KDPW_CCP	55.84	16.09	15.93	9.62	2.52
Eurex Clearing AG	77.59	6.86	14.20	0.09	1.26
Cassa di Compensazione e Garanzia S.p.A. (CCG)	53.15	23.34	23.34	0.08	0.09
LCH Clearnet SA	82.83	8.50	8.50	0.17	0.00
LCH Clearnet Ltd	87.98	5.97	5.97	0.08	0.00
European Commodity Clearing (ECC)	n/a	n/a	n/a	n/a	n/a
Keler CCP	n/a	n/a	n/a	n/a	n/a
CCP Austria GmbH	n/a	n/a	n/a	n/a	n/a
LME Clear Ltd	89.52	4.81	5.24	0.22	0.22
BME Clearing	90.82	2.93	5.86	0.13	0.26
OMIClear S.A.	60.96	28.96	0.00	1.87	8.21
ICE Clear Netherlands B.V.	61.65	32.33	0.00	0.52	5.51
ICE Clear Europe Limited	94.14	5.56	0.00	0.30	0.00

Source: own calculation.

Table 5
Default waterfall percentage structure in Q1 2016 (in %)

CCP	Default waterfall layer				
	initial margin	**prefunded resources**	**non--prefunded resources**	**SITG**	**CCP's capital**
Nasdaq OMX Clearing AB	85.87	7.62	5.12	0.34	1.05
European Central Counterparty N.V.	62.18	18.76	18.76	0.30	0.00
KDPW_CCP	55.89	16.47	16.32	8.97	2.35
Eurex Clearing AG	75.52	7.48	15.49	0.20	1.18
Cassa di Compensazione e Garanzia S.p.A. (CCG)	45.82	18.01	36.03	0.06	0.06
LCH Clearnet SA	83.05	8.40	8.40	0.15	0.00
LCH Clearnet Ltd	88.40	5.76	5.76	0.08	0.00
European Commodity Clearing (ECC)	n/a	n/a	n/a	n/a	n/a
Keler CCP	n/a	n/a	n/a	n/a	n/a
CCP Austria GmbH	18.72	13.09	65.44	1.38	1.38
LME Clear Ltd	89.89	4.63	5.05	0.21	0.21
BME Clearing	90.35	3.10	6.21	0.11	0.23
OMIClear S.A.	59.32	33.45	0.00	1.34	5.89
ICE Clear Netherlands B.V.	54.96	36.91	0.00	0.70	7.43
ICE Clear Europe Limited	84.51	14.91	0.00	0.58	0.00

Source: own calculation.

Table 6
Default waterfall percentage structure in Q2 2016 (in %)

CCP	Default waterfall layer				
	initial margin	prefunded resources	non--prefunded resources	SITG	CCP's capital
Nasdaq OMX Clearing AB	85.80	7.69	4.97	0.38	1.17
European Central Counterparty N.V.	68.38	15.69	15.69	0.25	0.00
KDPW_CCP	61.29	13.19	13.11	9.83	2.58
Eurex Clearing AG	76.81	7.10	14.72	0.20	1.18
Cassa di Compensazione e Garanzia S.p.A. (CCG)	48.02	17.29	34.57	0.06	0.06
LCH Clearnet SA	82.92	8.47	8.47	0.14	0.00
LCH Clearnet Ltd	89.23	5.35	5.35	0.07	0.00
European Commodity Clearing (ECC)	n/a	n/a	n/a	n/a	n/a
Keler CCP	44.91	21.53	21.53	2.42	9.62
CCP Austria GmbH	25.73	11.98	59.92	1.18	1.18
LME Clear Ltd	89.24	4.94	5.38	0.22	0.22
BME Clearing	89.78	3.28	6.57	0.12	0.24
OMIClear S.A.	61.39	31.97	0.00	1.23	5.41
ICE Clear Netherlands B.V.	65.65	25.98	0.00	0.72	7.65
ICE Clear Europe Limited	93.72	5.97	0.00	0.31	0.00

Source: own calculation.

Table 7
Default waterfall percentage structure in Q3 2016 (in %)

CCP	Default waterfall layer				
	initial margin	**prefunded resources**	**non--prefunded resources**	**SITG**	**CCP's capital**
Nasdaq OMX Clearing AB	86.44	6.86	4.49	0.32	1.89
European Central Counterparty N.V.	57.98	20.85	20.85	0.33	0.00
KDPW_CCP	59.67	15.44	15.36	9.51	0.02
Eurex Clearing AG	76.20	7.22	15.03	0.22	1.33
Cassa di Compensazione e Garanzia S.p.A. (CCG)	42.99	23.22	33.63	0.08	0.08
LCH Clearnet SA	79.15	10.34	10.34	0.17	0.00
LCH Clearnet Ltd	88.12	5.91	5.91	0.06	0.00
European Commodity Clearing (ECC)	77.61	7.46	5.69	3.22	6.01
Keler CCP	50.81	19.05	19.05	1.97	9.11
CCP Austria GmbH	18.05	13.30	66.52	1.06	1.06
LME Clear Ltd	89.83	4.66	5.08	0.21	0.21
BME Clearing	69.05	21.60	0.00	0.13	0.26
OMIClear S.A.	59.74	33.59	0.00	5.43	0.00
ICE Clear Netherlands B.V.	69.05	21.60	0.00	0.80	8.55
ICE Clear Europe Limited	94.24	5.46	0.00	0.30	0.00

Source: own calculation.

Table 8
Default waterfall percentage structure in Q4 2016 (in %)

CCP	Default waterfall layer				
	initial margin	prefunded resources	non--prefunded resources	SITG	CCP's capital
Nasdaq OMX Clearing AB	76.33	6.11	15.85	0.27	1.43
European Central Counterparty N.V.	51.05	24.21	24.21	0.53	0.00
KDPW_CCP	60.71	15.29	15.17	8.80	0.02
Eurex Clearing AG	78.21	6.56	13.70	0.22	1.31
Cassa di Compensazione e Garanzia S.p.A. (CCG)	46.62	26.61	26.61	0.08	0.08
LCH Clearnet SA	77.82	11.01	11.01	0.15	0.00
LCH Clearnet Ltd	87.77	6.09	6.09	0.06	0.00
European Commodity Clearing (ECC)	84.12	8.97	6.68	0.24	0.00
Keler CCP	49.01	19.96	19.96	2.21	8.85
CCP Austria GmbH	15.25	13.68	68.40	1.34	1.34
LME Clear Ltd	87.76	5.75	6.12	0.18	0.18
BME Clearing	85.44	4.69	9.37	0.17	0.34
OMIClear S.A.	60.91	32.39	1.23	1.23	5.47
ICE Clear Netherlands B.V.	56.90	34.25	0.00	0.76	8.09
ICE Clear Europe Limited	94.63	5.07	0.00	0.30	0.00

Source: own calculation.

Table 9
Default waterfall percentage structure in Q1 2017 (in %)

CCP	Default waterfall layer				
	initial margin	**prefunded resources**	**non--prefunded resources**	**SITG**	**CCP's capital**
Nasdaq OMX Clearing AB	87.21	6.86	4.62	0.28	1.03
European Central Counterparty N.V.	63.61	18.03	18.03	0.33	0.00
KDPW_CCP	48.89	20.29	20.17	10.62	0.02
Eurex Clearing AG	82.79	5.11	10.77	0.27	1.07
Cassa di Compensazione e Garanzia S.p.A. (CCG)	44.45	27.69	27.69	0.08	0.08
LCH Clearnet SA	77.73	11.07	11.07	0.14	0.00
LCH Clearnet Ltd	87.55	6.20	6.20	0.05	0.00
European Commodity Clearing (ECC)	76.81	13.09	9.69	0.41	0.00
Keler CCP	52.48	18.54	18.54	0.41	8.34
CCP Austria GmbH	22.13	12.61	63.07	1.09	1.09
LME Clear Ltd	87.22	6.01	6.39	0.19	0.19
BME Clearing	84.19	5.13	10.27	0.14	0.27
OMIClear S.A.	62.59	30.62	0.00	1.25	5.55
ICE Clear Netherlands B.V.	65.53	25.98	0.00	0.73	7.76
ICE Clear Europe Limited	94.01	5.68	0.00	0.30	0.00

Source: own calculation.

Table 10
Default waterfall percentage structure in Q2 2017 (in %)

CCP	Default waterfall layer				
	initial margin	prefunded resources	non--prefunded resources	SITG	CCP's capital
Nasdaq OMX Clearing AB	86.97	7.06	4.74	0.28	0.94
European Central Counterparty N.V.	66.12	16.79	16.79	0.30	0.00
KDPW_CCP	45.56	20.27	20.14	11.43	2.60
Eurex Clearing AG	76.32	7.19	15.01	0.29	1.18
Cassa di Compensazione e Garanzia S.p.A. (CCG)	47.99	25.92	25.92	0.08	0.08
LCH Clearnet SA	71.74	14.06	14.06	0.15	0.00
LCH Clearnet Ltd	85.76	7.09	7.09	0.05	0.00
European Commodity Clearing (ECC)	74.47	14.36	10.74	0.43	0.00
Keler CCP	59.51	17.73	17.73	2.02	3.02
CCP Austria GmbH	12.43	14.36	71.80	0.71	0.71
LME Clear Ltd	86.38	6.39	6.81	0.21	0.21
BME Clearing	81.43	5.99	11.97	0.25	0.37
OMIClear S.A.	63.16	30.57	0.00	1.17	5.10
ICE Clear Netherlands B.V.	n/a	n/a	n/a	n/a	n/a
ICE Clear Europe Limited	93.63	6.05	0.00	0.32	0.00

Source: own calculation.

Table 11
Default waterfall percentage structure in Q3 2017 (in %)

CCP	Default waterfall layer				
	initial margin	**prefunded resources**	**non--prefunded resources**	**SITG**	**CCP's capital**
Nasdaq OMX Clearing AB	86.59	7.26	4.98	0.26	0.90
European Central Counterparty N.V.	64.29	17.70	17.70	0.32	0.00
KDPW_CCP	50.04	17.63	17.50	12.09	2.75
Eurex Clearing AG	79.25	6.19	13.03	0.31	1.22
Cassa di Compensazione e Garanzia S.p.A. (CCG)	51.47	24.17	24.14	0.11	0.11
LCH Clearnet SA	71.78	14.04	14.04	0.14	0.00
LCH Clearnet Ltd	87.65	6.15	6.15	0.05	0.00
European Commodity Clearing (ECC)	78.23	12.49	8.84	0.43	0.00
Keler CCP	52.97	21.22	21.22	2.10	2.48
CCP Austria GmbH	14.16	14.05	70.23	0.79	0.79
LME Clear Ltd	80.73	9.27	9.63	0.18	0.18
BME Clearing	72.51	6.73	20.20	0.22	0.33
OMIClear S.A.	63.64	30.52	0.00	1.09	4.75
ICE Clear Netherlands B.V.	n/a	n/a	n/a	n/a	n/a
ICE Clear Europe Limited	92.43	7.24	0.00	0.33	0.00

Source: own calculation.

Table 12
Default waterfall percentage structure in Q4 2017 (in %)

CCP	Default waterfall layer				
	initial margin	prefunded resources	non--prefunded resources	SITG	CCP's capital
Nasdaq OMX Clearing AB	86.12	7.57	5.13	0.25	0.93
European Central Counterparty N.V.	57.01	21.30	21.30	0.38	0.00
KDPW_CCP	50.63	17.97	17.83	11.12	2.45
Eurex Clearing AG	78.21	6.54	13.72	0.31	1.23
Cassa di Compensazione e Garanzia S.p.A. (CCG)	47.67	26.07	26.07	0.10	0.10
LCH Clearnet SA	69.89	14.99	14.99	0.13	0.00
LCH Clearnet Ltd	87.62	6.17	6.17	0.05	0.00
European Commodity Clearing (ECC)	83.12	9.78	6.71	0.39	0.00
Keler CCP	51.25	21.59	21.59	2.23	3.34
CCP Austria GmbH	14.80	13.83	69.14	1.11	1.11
LME Clear Ltd	80.70	9.33	9.65	0.16	0.16
BME Clearing	66.04	8.36	25.08	0.21	0.31
OMIClear S.A.	67.86	26.05	0.00	1.14	4.95
ICE Clear Netherlands B.V.	n/a	n/a	n/a	n/a	n/a
ICE Clear Europe Limited	92.28	7.38	0.00	0.34	0.00

Source: own calculation.

Table 13
Overmargining ratio in Q4 2015–Q4 2017

CCP	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017
Nasdaq OMX Clearing AB	1.926	2.263	1.271	1.241	1.217	1.131	1.235	1.262	1.146
European Central Counterparty N.V.	2.622	1.285	1.679	1.537	2.103	1.428	1.595	1.837	1.601
KDPW_CCP	1.016	1.011	0.996	1.013	1.009	1.785	1.868	1.859	1.723
Eurex Clearing AG	1.312	1.448	1.425	1.444	1.381	1.245	1.252	1.203	1.254
Cassa di Compensazione e Garanzia S.p.A. (CCG)	1.137	1.131	1.134	1.189	1.283	1.307	0.930	0.904	0.817
LCH Clearnet SA	0.950	0.911	0.930	1.127	1.090	1.041	1.218	1.083	1.123
LCH Clearnet Ltd	1.193	1.195	1.231	1.196	1.180	1.197	1.204	1.207	1.196
European Commodity Clearing (ECC)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Keler CCP	n/a	n/a	3.174	2.559	2.952	2.706	2.566	2.988	3.499
CCP Austria GmbH	n/a	6.483	4.485	5.748	7.410	4.556	5.481	4.533	7.512
LME Clear Ltd	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.124	1.326
BME Clearing	1.091	1.099	1.287	1.174	1.342	1.245	1.302	1.247	1.215
OMIClear S.A.	1.111	1.105	1.084	1.068	1.067	1.010	1.095	1.084	1.672
ICE Clear Netherlands B.V.	1.648	2.381	2.139	2.187	2.612	2.165	n/a	n/a	n/a
ICE Clear Europe Limited	1.059	1.062	1.063	1.053	1.059	1.067	1.064	1.094	1.075

Note: the results for ECC are not available as the CCP does not report 6.2.15.

Source: own calculation.

Table 14
Overcollateralisation of DF ratio in Q4 2015–Q4 2017

CCP	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017
Nasdaq OMX Clearing AB	1.132	1.153	1.195	1.274	1.299	1.091	1.147	1.143	1.032
European Central Counterparty N.V.	1.075	1.114	1.182	1.174	1.256	1.115	1.102	1.082	1.067
KDPW_CCP	1.044	1.049	1.129	1.052	1.042	1.031	1.076	1.116	1.091
Eurex Clearing AG	1.145	1.170	1.208	1.296	1.320	1.335	1.186	1.366	1.308
Cassa di Compensazione e Garanzia S.p.A. (CCG)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
LCH Clearnet SA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
LCH Clearnet Ltd	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.001
European Commodity Clearing (ECC)	n/a	n/a	n/a	1.000	1.000	1.000	1.000	1.000	1.000
Keler CCP	n/a	n/a	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CCP Austria GmbH	n/a	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
LME Clear Ltd	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
BME Clearing	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
OMIClear S.A.	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ICE Clear Netherlands B.V.	1.095	1.211	1.138	1.117	1.013	1.127	n/a	n/a	n/a
ICE Clear Europe Limited	1.024	1.023	1.031	1.050	1.046	1.026	1.077	1.018	1.025

Source: own calculation.

Table 15
Total overcollateralisation ratio in Q4 2015–Q4 2017

CCP	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017
Nasdaq OMX Clearing AB	1.843	2.187	1.266	1.243	1.222	1.128	1.229	1.254	1.138
European Central Counterparty N.V.	1.921	1.245	1.587	1.441	1.831	1.359	1.495	1.674	1.456
KDPW_CCP	1.022	1.020	1.020	1.011	1.016	1.564	1.624	1.666	1.558
Eurex Clearing AG	1.299	1.423	1.406	1.431	1.377	1.250	1.247	1.214	1.258
Cassa di Compensazione e Garanzia S.p.A. (CCG)	1.095	1.094	1.095	1.123	1.180	1.189	0.954	0.935	0.882
LCH Clearnet SA	1.052	0.919	0.937	1.112	1.079	1.036	1.182	1.070	1.102
LCH Clearnet Ltd	1.181	1.183	1.218	1.183	1.169	1.184	1.189	1.194	1.183
European Commodity Clearing (ECC)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Keler CCP	n/a	n/a	2.469	2.134	2.387	2.260	2.206	2.419	2.759
CCP Austria GmbH	n/a	4.227	3.378	3.733	4.379	3.265	3.079	2.774	4.367
LME Clear Ltd	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.111	1.292
BME Clearing	1.088	1.096	1.277	1.165	1.324	1.231	1.282	1.226	1.191
OMIClear S.A.	1.075	1.067	1.055	1.044	1.044	1.007	1.064	1.057	1.486
ICE Clear Netherlands B.V.	1.458	1.911	1.856	1.932	2.011	1.870	n/a	n/a	n/a
ICE Clear Europe Limited	1.057	1.059	1.061	1.053	1.059	1.065	1.065	1.089	1.071

Note: the results for ECC are not available as the CCP does not report 6.2.15.

Source: own calculation.

Table 16
Mean average indicator in Q4 2015–Q4 2017

CCP	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017
Nasdaq OMX Clearing AB	1.772	1.962	2.037	1.713	1.394	1.763	1.773	1.501	1.838
European Central Counterparty N.V.	6.575	7.393	8.141	16.503	8.656	12.444	11.610	10.847	10.462
KDPW_CCP	2.639	3.013	2.837	5.602	5.607	4.795	3.961	3.523	3.202
Eurex Clearing AG	1.440	1.505	1.710	1.794	1.609	1.540	1.511	1.130	1.178
Cassa di Compensazione e Garanzia S.p.A. (CCG)	5.531	1.887	2.020	2.238	2.581	2.432	2.542	1.685	2.092
LCH Clearnet SA	4.013	4.879	6.377	5.674	4.831	4.667	4.100	4.001	3.739
LCH Clearnet Ltd	1.905	2.084	2.137	2.344	2.267	2.064	2.067	1.699	1.694
European Commodity Clearing (ECC)	n/a	n/a	n/a	3.023	2.451	2.350	1.886	1.472	1.472
Keler CCP	n/a	n/a	9.265	9.248	7.911	8.577	6.210	5.561	9.308
CCP Austria GmbH	n/a	1.487	1.307	1.975	1.801	1.814	2.881	2.509	1.543
LME Clear Ltd	2.633	3.840	8.349	4.867	3.461	2.186	1.612	1.874	1.450
BME Clearing	0.801	0.644	0.249	0.885	0.743	0.863	0.970	0.995	1.086
OMIClear S.A.	1.210	1.821	1.614	1.465	1.239	1.137	1.185	1.316	1.101
ICE Clear Netherlands B.V.	10.261	7.818	6.156	6.861	18.797	22.020	n/a	n/a	n/a
ICE Clear Europe Limited	1.666	0.706	2.155	2.312	2.351	2.430	2.253	2.258	2.018

Source: own calculation.

Table 17
Peak indicator in Q4 2015–Q4 2017

CCP	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017
Nasdaq OMX Clearing AB	1.215	1.219	1.256	1.385	1.149	1.188	1.195	3.335	1.329
European Central Counterparty N.V.	1.049	1.047	1.049	1.049	0.489	0.661	0.661	1.764	1.764
KDPW_CCP	1.470	1.564	1.420	2.449	2.031	1.955	1.863	1.598	1.482
Eurex Clearing AG	1.008	0.982	0.969	0.986	0.980	1.050	1.091	0.912	0.957
Cassa di Compensazione e Garanzia S.p.A. (CCG)	1.155	1.106	1.173	1.267	1.382	1.240	1.353	0.919	1.114
LCH Clearnet SA	1.401	1.335	1.549	2.029	2.367	2.071	2.219	2.412	2.524
LCH Clearnet Ltd	1.374	1.556	1.451	1.339	1.446	1.305	1.259	1.124	1.365
European Commodity Clearing (ECC)	n/a	n/a	n/a	1.369	0.778	0.899	0.934	0.812	0.821
Keler CCP	n/a	n/a	1.821	1.903	1.767	2.344	1.615	1.798	3.889
CCP Austria GmbH	n/a	0.848	0.898	1.405	1.223	0.928	1.509	1.338	0.950
LME Clear Ltd	0.713	0.714	2.497	1.266	1.102	1.112	1.085	1.027	0.865
BME Clearing	0.431	0.241	0.584	0.349	0.290	0.228	0.254	0.307	0.383
OMIClear S.A.	0.814	1.054	1.040	1.087	1.011	0.944	0.946	1.011	0.833
ICE Clear Netherlands B.V.	2.278	1.934	1.334	1.555	2.566	4.414	n/a	n/a	n/a
ICE Clear Europe Limited	1.524	0.768	1.539	1.428	1.472	1.385	1.419	1.334	1.335

Source: own calculation.