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The Impact of CCP Liquidity and Capital Demands on Clearing Members Under Stress

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Why These Findings Are Important

Under stress conditions, liquidity and capital demands by central counterparties (CCPs) can affect clearing members (CMs). In these extreme scenarios, there are potential systemic vulnerabilities and resilience in centrally cleared markets and a need to monitor the potential impact of CCPs on their clearing members. By applying stress scenarios to 11 major CCPs and 6 CMs that are large U.S. financial institutions, the understanding is that while large clearing members have sufficient resources to meet CCP demands during periods of heightened risk, the size of these demands is material.

Key Findings

1. **The largest clearing members have resources to meet hypothetical demands from CCPs in extreme scenarios.**
2. **The sufficiency of clearing member resources varies over time across member and CCP.**
3. **Correlation in shocks across CCPs suggests clearing members will face additional resource demands from multiple CCPs in times of stress.**

How the Authors Reached These Findings

The authors combine public data and supervisory data for their analysis. The public data includes CCP CPMI-IOSCO Public Quantitative Disclosures, U.S. G-SIB Liquidity Coverage Ratio Disclosures (LCR), and Dodd-Frank Annual Stress Testing (DFAST) Results. The supervisory data includes results from U.S. G-SIB stress testing reported in FR Y-14Q Schedule L and are not publicly available. The authors construct a stress test where shocks hit CCPs and propagate to their clearing members according to the CCP waterfall structure. They assess whether certain large clearing members can meet such demands.

The Impact of CCP Liquidity and Capital Demands on Clearing Members Under Stress[1]

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Abstract

We examine the impact of liquidity and capital demands by central counterparties (CCPs) on clearing members (CMs) under stress conditions. Our methodology provides insights into potential systemic vulnerabilities and resilience in centrally cleared markets and can be used to monitor the potential impact of CCPs on their clearing members. We consider 11 major CCPs and 6 CMs that are large U.S. financial institutions. We apply various stress scenarios to both CCPs and CMs and find that, while large clearing members have sufficient resources to meet CCP demands during periods of heightened risk, the size of these demands is material and has fluctuated over time.

Introduction

The 2007-2008 Great Financial Crisis revealed that bilateral, over-the-counter trading in derivatives suffered from low collaterization and lax risk management standards. To improve risk management and make these markets more transparent, regulators across the world mandated the use of central clearing. Central clearing shifts the credit risk of a financial transaction between two counterparties to the central counterparty (CCP) which becomes the seller to the buyer and the buyer to the seller. If neither party defaults, the CCP's position is balanced: any amount it collects from the party with the financial loss in the transaction, it delivers to the party with the financial gain. But the CCP needs to deliver even if the party with the financial loss were to default.

To manage this default risk, especially in the case of derivatives transactions where the risk may shift from one party to the other during the life of the contract, the CCP collects resources from both parties periodically. The amount the CCP collects depends on the risk of the transaction, the change in the value of the underlying contract, and whether one of the CCP's clearing members (CMs) has defaulted. In this paper we consider the effects of CCP demands for resources on clearing members and specifically ask whether members have sufficient resources to respond to them during times of stress, for both the CCPs and the CMs.

Evaluating CCP demands on CMs involves understanding how stress conditions—whether affecting the CCP or the CMs—translate into increased liquidity or capital needs. During times of market stress, CCP demands for additional resources can place significant pressure on clearing members, forcing them to

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[1] The views expressed in this working paper are those of the authors and do not necessarily represent official positions or policy of the OFR or the U.S. Department of the Treasury.
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rapidly mobilize cash or highly liquid assets. These demands are likely to occur at a time when market disruptions may separately stress clearing members, either through losses they incur outside their positions with the CCP or stress on their liquid resources due to, in the case of banks, large withdrawals from depositors. Evaluating CCP demands thus requires a holistic approach that considers both CCP-level stresses, like potential member defaults, and the separate stress conditions that clearing members might be experiencing concurrently.

Our analysis considers 11 of the largest CCPs across the world and 6 clearing members that are large US financial institutions. We stress the CCPs in three ways: by applying idiosyncratic shocks specific to each CCP; by applying systematic shocks simultaneously across all CCPs; and by applying a reverse stress scenario that exhausts the resources and assessment powers of each CCP. We use information provided by the CCPs as well as information provided by the six clearing members to translate these scenarios into demands from the CCP towards each clearing member. Simultaneously we consider two stress scenarios for the CMs. The first scenario is the severely adverse scenario of the Dodd-Frank Annual Stress Test (DFAST) framework which stresses capital resources. The second scenario is the stress scenario in the Liquidity Coverage Ratio (LCR) test which stresses high-quality liquid assets (HQLA) by assuming net cash outflows over a 30-day period due to specified factors, including assumptions on deposit withdrawals and credit line drawdowns.

Our findings show that even when both the CCP and CMs face simultaneous stress, their largest CMs have sufficient capital and liquidity resources to meet CCP demands. Still, the size of these demands is non-negligible. Assessments from a single CCP could demand as much as 6.4% of a CM's outstanding liquid resources and 3.1% of its capital. If multiple CCPs were forced to make capital calls at once, the demands could rise to as much as 25.7% of a CM's liquid and 11.7% of its capital resources. Moreover, there has been fluctuation in this amount over time; it has been as high as 32.2% of the average CM's liquid resources and 13.3% of its capital resources. To ensure that CCPs are adequately prepared to cover extreme losses, particularly in periods of systemic market stress, it is important to continue monitoring these statistics and to expand the analysis to other CMs for whom such measures are not as readily available.

Literature Review

The literature on central counterparties, their resilience, and their impact on financial markets and market participants is small but growing. Our paper contributes to this literature by studying scenarios that simultaneously stress CCPs and their CMs and evaluating the impact on the capital and liquidity resources of the CMs.

The importance of CCP stress testing was emphasized by the Basel Committee on Banking Supervision (BCBS) and the International Organization of Securities Commissions (IOSCO) in their Principles for Financial Market Infrastructures (PFMI) (CPMI-IOSCO, 2012). These guidelines require CCPs to conduct regular stress testing of credit and liquidity risks to ensure they can survive extreme market shocks. Stress tests must be performed at least quarterly, using both historical and hypothetical scenarios. In the European Union the European Market Infrastructure Regulation (EMIR) and in the United States the Dodd-Frank Act mandate CCPs to develop and implement robust stress testing models. They also require transparent disclosure of stress testing outcomes to regulators. Stress testing methods include using historical scenarios (for example past financial crises) as stress scenarios; hypothetical scenarios, such as extreme interest rate shifts or unprecedented market volatility; and reverse stress testing, identifying conditions that would result in CCP failure, thus helping CCPs anticipate vulnerabilities.

Duffie (2018) argues that CCPs stress testing frameworks often fail to account for correlated defaults, which can exacerbate systemic risks. Paddrik et al. (2020) argue that stress tests should incorporate potential fire sales or reluctance by CMs to meet margin calls during stressed conditions, which may amplify the CCP's liquidity pressures. Aldasoro et al. (2023) highlight the growing importance of macroprudential stress testing—a system-wide approach that evaluates interconnectedness between multiple CCPs, financial institutions, and markets. Berner et al. (2019) propose supplementing existing stress tests with a high-frequency indicator, using SRISK to assess stress on CCPs due to capital losses at CMs associated with large market downturns.

While stress testing generally focuses on credit risks, liquidity risk is equally critical for CCPs. Haene and Sturm (2009) discuss how CCP liquidity stress tests must account for market liquidity conditions, as CCPs may need to liquidate collateral to meet obligations. Murphy, Vasios, and Vause (2016) emphasize the need for CCPs to diversify liquidity sources, including committed credit lines, central bank access, and high-quality liquid assets. Sidanius and Zikes (2012) present a theoretical framework for incorporating liquidity risk into stress testing, highlighting the interaction between credit risk and liquidity demands under stress conditions. Closer to our paper, Huang and Takáts (2024) find that CCPs can face significant liquidity challenges during market-wide stress events, where multiple CMs struggle to meet liquidity demands simultaneously. In our paper we evaluate the magnitude of these challenges under several detailed scenarios that build on public and supervisory information. Our scenarios simultaneously stress CCPs and CMs, and find that, while CMs can meet resource demands from CCPs, these demands are significant.

Institutional Setting: The Default Waterfall

To understand the various demands that a CCP may place on the two parties to a transaction we describe the nature of all the resources available to a CCP, called the CCP's *default waterfall.* The purpose of a CCP's default waterfall is to ensure that, in the case of the default of one or more of the CCP's clearing members, any losses to the CCP can be managed in an orderly fashion, while maintaining the CCP's operational continuity during stress periods. To achieve this purpose, the waterfall consists of several layers. The first layer includes the resources provided by the defaulting CM. These resources include: initial margin (IM), which is held to cover potential future exposures over a specified liquidation period; variation margin (VM), which covers fluctuations in the market value of the CM's positions over a short period of time (usually daily), and default fund contributions by the defaulter, i.e., a pre-funded contribution from the defaulting member to a default fund, which is pooled across all members.

Whether losses by a defaulting member translate to losses to the CCP and other CMs depends on the size of the loss. The first resource used to cover the loss by a defaulting member is the initial margin of the defaulter. If the loss is larger than the defaulter's IM, then the defaulter's contribution to the default fund (DF) is used. If the loss is even larger than both the IM and the default contribution of the defaulter, the next layer of protection is part of the CCP's own capital, often referred to as the CCP's *skin-in-the-game* (SITG). By ensuring that the CCP itself bears a portion of the losses before tapping into other members' contributions, SITG provides an incentive to the CCP to manage risk and aligns the CCP's interests with those of the clearing members.

If the losses exceed the contributions of the defaulter and the CCP's SITG, the CCP uses the DF contributions of other non-defaulting members. These contributions are meant to mutualize the losses, as members have collectively contributed to this pool to support the CCP's resilience. After exhausting the DF, the CCP may have the right to make assessment calls to non-defaulting members, requiring them to provide additional contributions. The amount that can be called from members is typically a multiple of their DF contributions. Once all losses are allocated, CCPs also require surviving clearing members to replenish the DF.

In the extreme case where the DF and assessments are exhausted, CCPs have other loss allocation mechanisms, like VM gains haircutting or partial tear-ups of contracts as further steps to allocate losses. Should all else fail, the CCP may enter a formal recovery phase that can include extreme actions up to the winding down of operations and the suspension of clearing services. We do not consider the case of CCP failure in our study but rather focus on the demands that a surviving CCP may place on its CMs.

We break down liquidity demands from a CCP to its clearing members into categories that track the CCP's DF: IM, VM, DF contributions, and assessments. IM is posted prior to the change in the value of a position. It is possible for IM to change even if the value of a position does not – for example if volatility increases, making extreme moves more likely. If VM is smaller than IM, then the CM needs to replenish the IM, otherwise it must also provide the amount by which VM exceeds IM, which is called exceedance. These payments must be made within a short period of time – typically a day or less. While IM and DF contributions are resources immediately available to the CCP, assessments are resources that need to be called, i.e., requested by the CCP.

Data & Summary Statistics

Our sample consists of 11 CCPs and 6 CMs. The CCPs are among the largest global CCPs and play an important role in global securities and derivatives markets. They are CME, FICC, ICC, ICUS, NSCC, OCC, JSCC, Eurex, ICE EU, LCH Ltd, and LCH SA. Where relevant, we consider clearing services for various products cleared by each CCP. Our CM sample consists of six US Global Systemically Important Banks (G-SIBs): Bank of America, Citigroup, Goldman Sachs, JP Morgan Chase, Morgan Stanley, and Wells Fargo.

These CCPs and CMs suit our analysis for two reasons. They comprise the heart of the clearing system, in that they are the entities responsible for covering most losses associated with counter-party default in derivatives and securities markets. Additionally, our analysis is feasible for this subset of CMs because our data permit us to estimate how aggregate CCP resource demands would be allocated to each. The estimation approach could be expanded to other CMs and CCPs with appropriate data.

CCPs

The CCPs in our sample play an outsize role in the clearing of global securities and derivatives markets. Globally, there are over 100 CCPs in total and, of these, 46 of the largest provide quarterly Public Quantitative Disclosures (PQDs) in keeping with the Principles for Financial Market Infrastructures (PFMI). The PQDs provide, at the level of every clearing service, information on the aggregate resources available to the CCP. Specifically, they provide aggregate initial and variation margins, the size of the skin-in-the-game and the size of the DF, as well as information on exceedances of prefunded CCP resources and the limits, if any, on CCP assessment powers.

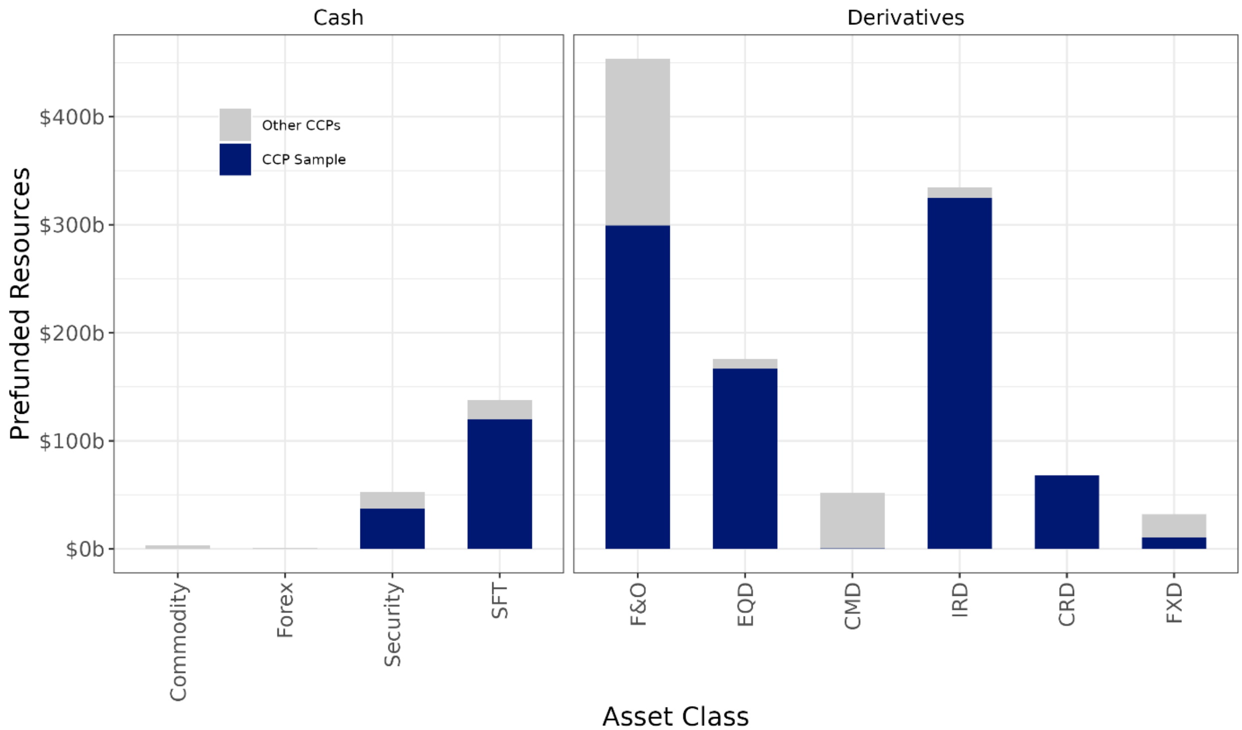

Figure 1. Pre-funded Resources by Asset Class Q1 2024.
The figure shows the pre-funded resources; i.e., the sum of the IM and the DF, for CCPs in our sample vs. other CCPs. The figure includes information for commodities, foreign exchange (Forex), securities, securities financing transactions (SFT), futures and options (F&O), equity derivatives (EQD), commodity derivatives (CMD), interest rate derivatives (IRD), credit derivatives (CRD), and foreign exchange derivatives (FXD).
Sources: ClarusFT CCPView, Authors' analysis.

Figure 1 shows that our sample of 11 CCPs accounts for 78% of the pre-funded resources reported in the PQDs. Assuming that the prefunded resources represent the risk associated with trading, this suggests that our sample of CCPs is responsible for most of the risk-weighted outstanding volume of activity. Our sample coverage is particularly good in securities, securities financing transactions, equity derivatives, interest rate derivatives, and credit derivatives.

There is a considerable degree of interconnection between our sample of CMs and of CCPs. The CMs and their subsidiaries are almost universally members at our sample of CCPs (see ***Figure 2***). In fact, they are very often General CMs, in that they guarantee cleared trades on behalf of clients in addition to their own positions. The only exception is Wells Fargo, which is not a member with any clearing service with JSCC, Eurex, or LCH SA.

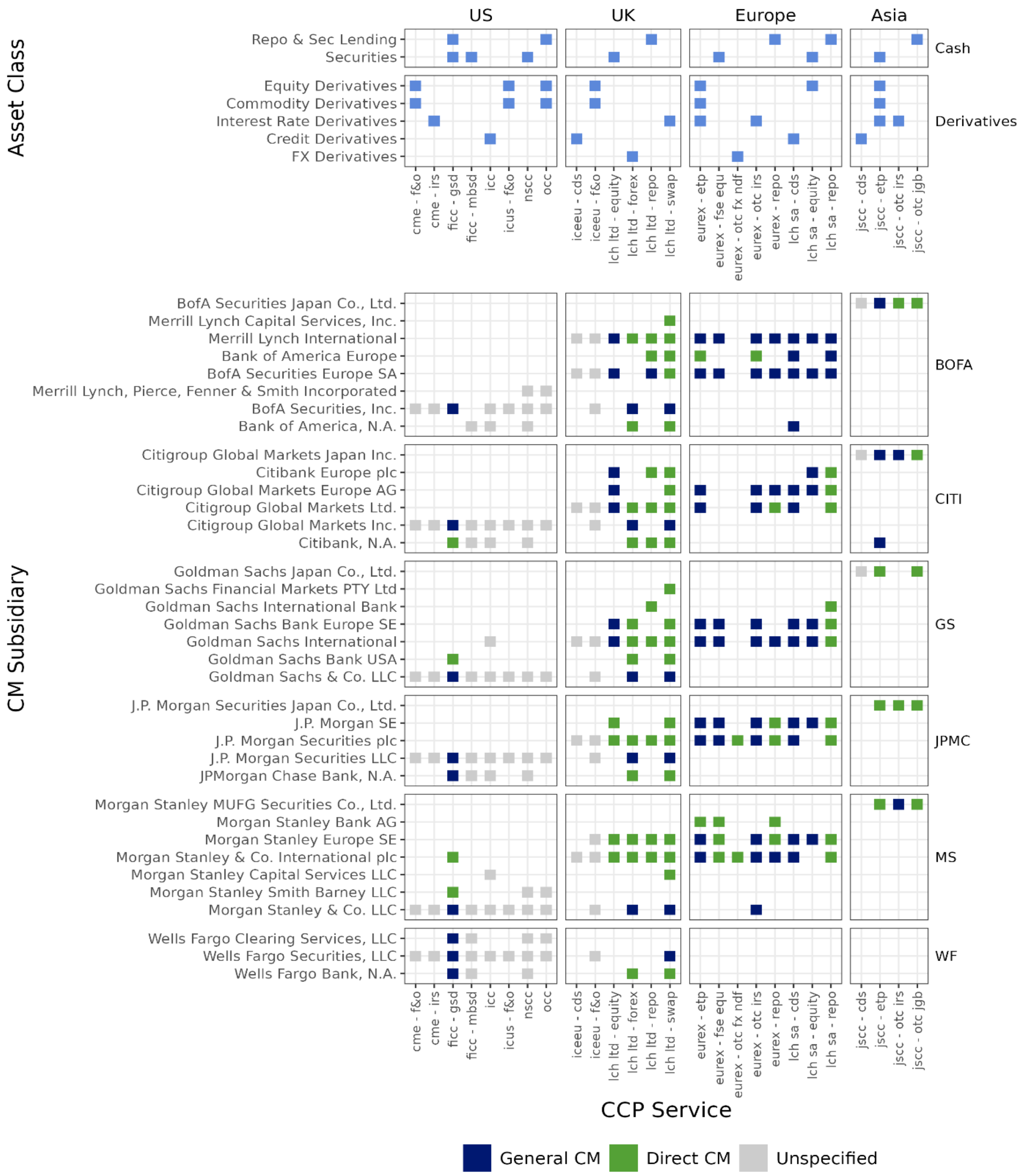

Figure 2. CCP Service Asset Classes and Membership. The top panel shows the asset classes cleared at each clearing service at the CCPs in our sample (CME futures and options, CME interest rate swaps, FICC government security derivatives, FICC mortgage-backed security derivatives, ICC, ICUS futures and options, NSCC, OCC, ICE EU credit default swaps, ICE EU futures and options, LCH Ltd equities, LCH Ltd foreign exchange derivatives, LCH Ltd repos, LCH Ltd swaps, Eurex exchange traded products, Eurex Frankfurt Stock Exchange equities, Eurex over-the-counter foreign exchange non-deliverable futures, Eurex over the counter interest rate swaps, Eurex repo, LCH SA credit default swaps, LCH SA equity, LCH SA repo, JSCC credit default swaps, JSCC exchange traded products, JSCC over-the-counter interest rate swaps, and JSCC over-the-counter Japanese government bonds). The bottom panel shows whether the six US G-SIBs (Bank of America, Citibank, Goldman Sachs, JP Morgan Chase, Morgan Stanley, and Wells Fargo) or their subsidiaries are either general or direct clearing members for each of the clearing services.
Sources: CCP membership lists, Authors' creation.

Table 1 provides aggregate information on the default waterfall of the CCPs we consider. The table also lists the assessment powers of each CCP, the demands it placed on CMs during Q1 2024 relative to the size of the CCP's prefunded resources (i.e., the CCP's initial margin, default fund, and skin-in-the-game), and the share of the CCP's IM and DF by the CMs in our sample.

	US						UK		Europe		Asia
	CME	**FICC**	**ICC**	**ICUS**	**NSCC**	**OCC**	**ICE EU**	**LCH Ltd**	**Eurex**	**LCH SA**	**JSCC**
Governance											
Parent Entity	CME	DTCC	ICE	ICE	DTCC	OCC	ICE	LCH Ltd	Eurex	LCH SA	JSCC
Major Services	F&O, IRS	GSD, MBSD	CDS	F&O	Equity	F&O	F&O, CDS*	Equity, Forex, Repo, Swap	ETP, FSE Equity, OTC FX, OTC IRS, Repo	CDS, Equity, Repo	CDS, ETP, OTC IRS, OTC JGB
Member-Owned		x			x						
Prefunded Resources											
PRF	$505b	$52b	$53b	$18b	$12b	$121b	$77b	$255b	$98b	$55b	$51b
IM/PRF	96.0%	0.0%	92.8%	95.1%	0.0%	84.5%	96.0%	96.2%	92.3%	85.7%	87.8%
DF/PRF	3.9%	99.7%	7.1%	4.5%	98.9%	15.3%	3.8%	3.8%	7.5%	14.1%	11.8%
Committed Resources											
DF	$19b	$52b	$4b	$0.8b	$12b	$19b	$3b	$10b	$7b	$8b	$6b
CM Default Loss CMT/DF	219.9%	0.0%	99.3%	199.9%	0.0%	0.0%	200%	100%	200%	100%	232.6%
CCP Default Loss CMT/DF	-	-	-	-	-	-	-	-	8.9%	-	-
Replenish DF CMT/DF	-	-	-	-	-	-	-	100%	100%	100%	-
Resource Demands											
Max Agg VM/PRF	3.0%	32.7%	1.7%	9.3%	30.9%	-	7.1%	8.3%	8.0%	4.5%	10.5%
New Agg EXCD/PRF	0.0%	8.5%	0.0%	0.0%	2.6%	0.3%	1.0%	1.3%	2.2%	0.1%	1.3%
Max Agg IM Call/PRF	0.8%	15.3%	3.2%	3.6%	51.6%	8.1%	5.1%	4.1%	8.5%	7.6%	6.7%
US G-SIB Exposure											
US G-SIB IM/Tot IM	5.4%	n/a	22.1%	14.9%	n/a	6.7%	18.9%	18.5%	13.0%	16.0%	14.2%
US G-SIB DF/Tot DF	30.3%	26.8%	58.7%	52.9%	**	45.3%	41.6%	31.1%	28.9%	28.3%	20.2%

Table 1. CCP Summary Statistics. The 11 CCPs in our sample are grouped by region and summarized. Prefunded resources (PRF) include the total of IM, DF, and CCP skin-in-the-game capital. We describe initial margin relative to prefunded resources (IM/PRF) and default fund relative to prefunded resources (DF/PRF). Committed resources (CMT) refer to commitments to cover default losses exceeding the DF by the clearing members or the CCP owners (CM & CCP Default Loss CMT), or commitments to replenish the default fund after its use (Replenish DF CMT). Reported prefunded and committed resources are single quarter values from 2024 Q1. Reported CCP resource demands include the maximum aggregate daily VM call in a quarter (Max Agg VM), the new aggregate exceedance volume during the quarter across all accounts (New Agg EXCD), and the maximum aggregate daily IM top-up call in the quarter (Max Agg IM Call). Reported values are average demands relative to contemporaneous total prefunded resources (PRF) from 2017 Q2-2024 Q1. US G-SIB exposures are the fraction of contemporaneous IM and DF contributed by FR Y-14Q reporting institutions, averaged from 2017 Q2-2024Q1.
*Note: *ICE EU CDS has been discontinued since October 2023 but was present for part of our historical sample. **Certain data points are masked to avoid possible disclosure of proprietary information of individual FR Y-14Q filers.*
Sources: ClarusFT CCPView, FR Y-14Q Schedule L, Authors' analysis

Figure 3 depicts the assessment powers at clearing services of the largest CCPs relative to the size of the DF during Q1 2024. A CCP may turn to its assessment powers in a tail event after default losses it incurs exhaust available prefunded resources like the DF. The CCP is then entitled to demand that its clearing members promptly deliver additional resources. Some assessment powers are used to cover default losses that are unmet because they exceeded the DF. Others serve to replenish a depleted DF so that trade may resume after an episode of stress with appropriate collateral in place. We note that assessment powers tend to be higher in Europe and they tend to be lower at CCPs, like the FICC and the NSCC, that are member-owned. Assessment powers are comparable in size to the size of the DF and often larger. It is common for assessment powers to be twice the size of the DF. While assessment powers occasionally require CCP owners to provide more capital, for the most part they serve to procure capital from the CMs.

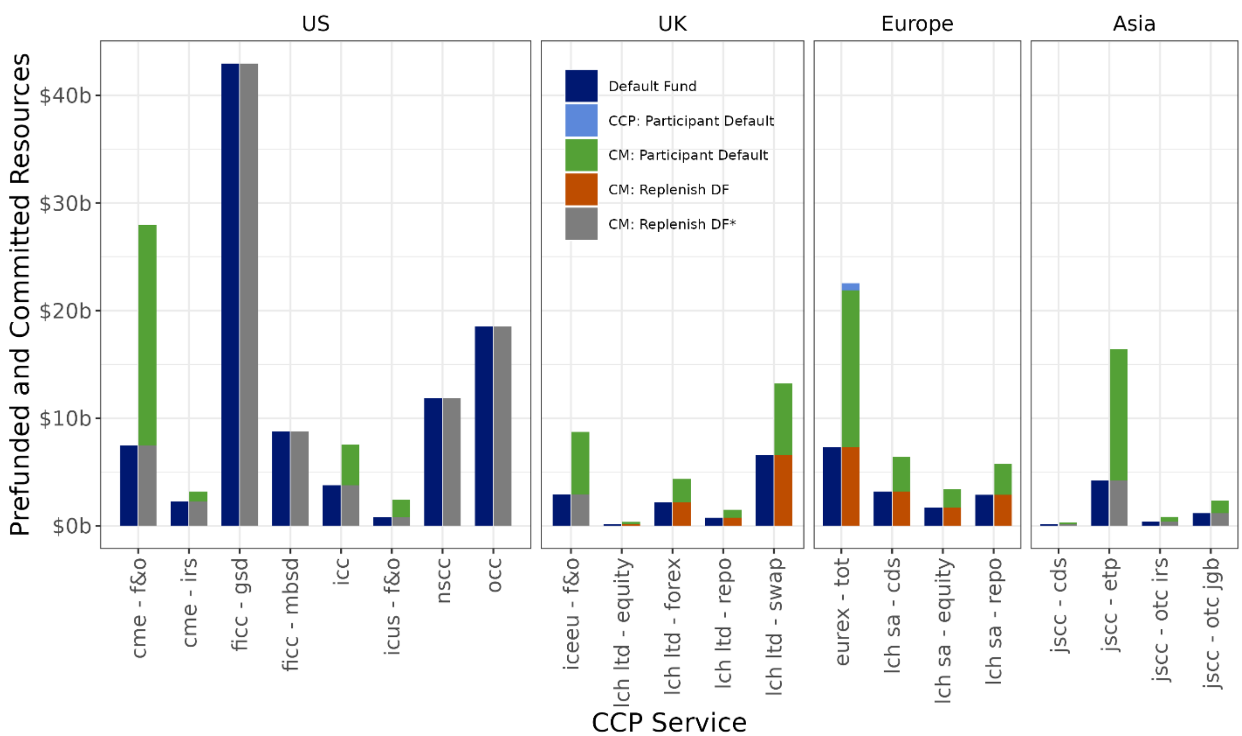

Figure 3. CCP Aggregate Default Fund and Assessment Powers Q1 2024. The figure shows the funds to be provided to cover losses (either by the CCP or the CMs), the amount that can be called to replenish the default fund, and the size of the default fund itself. The figure breaks down the information by region and clearing service.
*Note: *Where information on assessment powers for replenishing the DF is missing, we set this equal to 100% of the DF on the notion that this will be required for non-defaulted members to maintain their outstanding positions and client positions with the same risk buffers in the aftermath of a default by another member.*
Sources: ClarusFT CCPView, Authors' analysis

Clearing Members

The CMs in our sample provide information that can be used to evaluate both their exposure to CCPs and their resources under stress. The first dataset we use is the supervisory FR-Y14Q Schedule L report, a quarterly report filed by US G-SIBs. For each reporting institution, it includes information on the IM on house accounts,[4] as well as DF contributions. In addition, once a year (during the fourth quarter), the report includes information on the gains and losses of each institution toward each CCP where it is a member, under the severely adverse scenario in the Dodd-Frank Act Stress Tests (DFAST) stress testing framework.

The clearing members (CMs) in our sample are among the largest CMs at the relevant CCPs and are responsible for a considerable fraction of cleared trades as well as resource demands in the event of CCP stress. ***Figure 4*** illustrates the fraction of the DF at each CCP that was contributed by the six US G-SIBs in our sample (dark blue). It also illustrates the fraction of the DF contributed by the largest five (light blue) and ten (grey) members. These latter concentration measures are available through the public quantitative disclosures (PQDs) often at the level of the CCP service. In absolute terms, DF contributions from these US G-SIBs alone comprise 30-60% of the total DF resources at CCPs in our sample.

[4] House accounts hold the positions that a CM own themselves. By contrast, client accounts hold positions that CMs help facilitate on behalf of their clients. A CM is exposed to the market risk of a house position but not a client position, because in the latter case the client enjoys gains or suffers losses as the position moves.

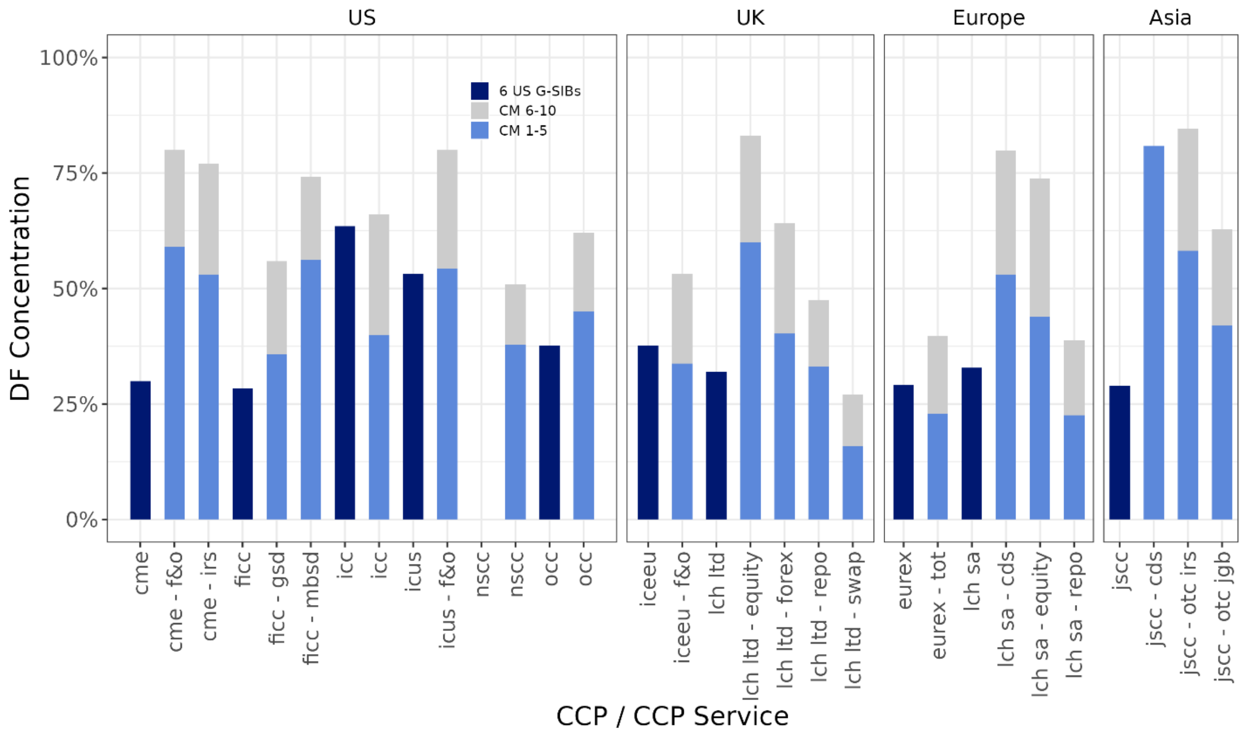

Figure 4. CCP Default Fund Concentration Q1 2024. The figure shows the default fund contributions by the US G-SIBs in our sample, as well as the default fund contributions by the five largest CMs and the sixth-to-tenth largest CMs. We note that information for the US G-SIBs is provided by CCP, while information on the contributions of the largest CMs is provided by clearing service.
Notes: Certain data points (e.g. NSCC) are masked to avoid possible disclosure of proprietary information of individual FR Y-14Q filers.
Sources: ClarusFT CCPView, FR Y-14Q Schedule L, Authors' analysis

We also use two datasets that capture the level of stress that financial institutions may experience. One dataset is a disclosure provided quarterly by large banks under the rule by the Board of Governors of the Federal Reserve System on "Liquidity Coverage Ratio: Public Disclosure Requirements." This disclosure lists the ratio of a bank's high-quality liquid assets (HQLA) to hypothesized net cash outflows over a 30-day period. Large banks are required to maintain a liquidity coverage ratio (LCR) greater than unity. These disclosures detail the mark-to-market value of high-quality liquid assets (HQLA) both before and after a hypothetical 30-day liquidity crunch such as deposit withdrawals and credit line drawdowns.

The last dataset consists of annual public disclosures by the Federal Reserve Board of Governors on the performance of large financial institutions under the severely adverse stress scenario in the DFAST stress testing framework.[5] This scenario specifies how various risk factors, e.g. rates and spreads, will change over a nine-quarter planning horizon. Banks project how the changes would affect the values of their balance sheets and income levels over the same planning horizon and estimate a variety of measures under stress. The most narrowly defined is the ratio of Common Equity Tier 1 (CET1) Capital to Risk Weighted Assets, which can be used to recover the bank's level of CET1 capital. CET1 capital consists of

[5] https://www.federalreserve.gov/supervisionreg/dfa-stress-tests-2024.htm

the bank's highest quality capital, including retained earnings and accumulated other comprehensive income (AOCI).[6] Lost DF contributions or CCP capital calls would come out of CET1 capital, making it an appropriate measure of bank solvency.

Table 2 presents data from LCR and DFAST disclosures for each of the six large US G-SIBs in our sample. The reduction in liquid assets is dramatic: for example, from the LCR disclosures, the remaining HQLA represents as little as 11% of the initial HQLA at Wells Fargo and Bank of America. We also note, in results we do not report, that the unstressed liquid assets of most banks have gradually increased, particularly after March 2020, while the remaining liquid assets after the 30-day stress period have remained flat.

Table 2 also reports the bank's actual CET1 capital before re-estimation under the stress scenario, as well as the stressed CET1 at the end of the severely adverse scenario in the DFAST disclosures. We note that, while the capitalization of these institutions drops due to the stress scenario, the drop in CET1 capital is considerably less than the reduction in HQLA under the LCR liquidity test. Moreover, the remaining CET1 capital under the severely adverse scenario in the DFAST stress testing framework tends to be larger than the remaining HQLA under the LCR liquidity test.

	BOFA	**CITI**	**GS**	**JPMC**	**MS**	**WF**
Balance Sheet						
Total RWA	\$1.5t	\$1.2t	\$0.6t	\$1.6t	\$0.4t	\$1.2t
HQLA/RWA	35.1%	42.7%	36.6%	41.5%	49.5%	30.8%
CET1/RWA	11.5%	12.4%	13.8%	12.9%	16.3%	11.4%
SLR	6.4%	6.2%	6.1%	6.2%	6.3%	7.3%
Stressed Resources						
Total HQLA	\$530b	\$490b	\$220b	\$650b	\$210b	\$370b
Stressed HQLA	\$83b	\$73b	\$50b	\$75b	\$51b	\$71b
Total CET1	\$170b	\$150b	\$83b	\$200b	\$69b	\$140b
Stressed CET1	\$140b	\$110b	\$49b	\$160b	\$46b	\$110b

Table 2. Clearing Member Sample Summary Statistics.
Sources: DFAST Public Disclosures, LCR Public Disclosures, Authors' analysis

[6] Note that while each of the G-SIBS is required to include AOCI in CET1, not all DFAST institutions are required to include AOCI in CET1: "Other comprehensive income is only calculated for banks subject to Category I or II standards or banks that opt in to including accumulated other comprehensive income (AOCI) in their calculation of capital." (2024 Federal Reserve Stress Test Results, p. 16)

Methodology

We are interested in understanding how distress and default losses at CCPs lead to the utilization of capital and liquid resources among the CMs. Depleted liquid or capital resources among CM banks could lead to panic, require central bank intervention, or, in the extreme, prompt bank resolution. To this end, we evaluate the demands that CCPs may pose on their CMs under stress conditions for both the CCPs and the CMs. Our analysis proceeds in three steps. First, we define what we mean by a shock to the CCP sector and calibrate scalable shocks for our analysis. We employ the aggregate maximum variation margin as our measure of shock to CCPs because it correlates with market stress and is readily available for the CCPs we study.

Second, we define how a CCP responds to a shock by making aggregate liquid and capital demands on clearing members by mapping the shocks to the aggregate maximum variation margin into CCP resource demands. Third and finally, we apportion aggregate demands to each of the clearing members in our sample, which, when combined with available stressed resources at each CM, enables us to estimate the CM resource utilization.

We note that our analysis makes two additional assumptions. We assume that, under the stressed conditions faced by the CCPs and the CMs, any CM whose prefunded resources (i.e., the CM's IM and DF contribution) are below that CM's VM defaults. We also assume that shocks to CCPs occur over a single day, at a time where CMs have already faced shocks to their liquidity (over a 30-day period, corresponding to the shock in the liquidity coverage ratio disclosures) and capital resources (over a period of several quarters, corresponding to the severely adverse scenario in the DFAST stress testing framework).

Defining CCP Shocks

We consider three types of scenarios. The first type – idiosyncratic scenarios – consists of shocks that occur separately at each CCP. In contrast, the second type of scenarios – systematic scenarios – consist of shocks that simultaneously affect every CCP in our sample. The third type is a reverse scenario that is tailored to exhaust CCP resources.

We construct scenarios of the first type by considering VM call data reported in the PQDs. Each quarter, CCPs report the maximum aggregate VM call made in a single day during that quarter. For each CCP, we take this quarterly time-series of maximum daily VM calls and calculate the average and standard deviation. A scenario corresponds to a VM call that is equal to the observed average maximum daily VM plus a multiple of the standard deviation of the maximum daily VM for that CCP. For example, over the period we consider, the average maximum daily VM call for ICUS is \$1.7b, while the standard deviation is \$1.1b. A 3-standard deviation scenario corresponds to a daily VM at ICUS of \$1.7b + 3 * \$1.1b = \$5b.

While idiosyncratic shocks apply to each CCP separately, much of the variation is driven by factors affecting all CCPs simultaneously, e.g., an increase in market volatility. To capture this commonality across CCPs, the second type of scenarios – the systematic scenario type – considers principal components analysis (PCA) of the daily maximum VMs, normalized by constructing z-scores, i.e., subtracting the mean maximum daily VM and dividing by the corresponding standard deviation.[7] In line with the results in King et. al (2022), our analysis shows that the first principal component explains 70% of the variation in the data, is positively correlated with the VIX (which captures market-wide volatility), and the maximum daily VMs for every CCP load positively on it.

The third scenario type is the reverse scenario that is large enough to exactly exhaust CCP resources. In particular, we determine a VM shock large enough that the associated default losses in excess of IM exhaust the CCP's prefunded resources, skin-in-the-game capital, and assessment powers. Assessment powers promise to help CCPs manage default losses by calling on the capital resources of their clearing members. In principle, they can cover losses that are large in magnitude, on the order of the size of the DF. However, because they fall late in the waterfall, they are only invoked in periods of severe distress, when CM balance sheets may have begun to deteriorate. This introduces uncertainty as to whether CMs will be able to meet these demands in the states of the world when they are invoked. Ultimately, the purpose of the third scenario is to evaluate whether assessment powers can be considered a reliable source of capital during a crisis.

The boxplots in ***Figure 5*** depict the VM shocks that form the basis of our analysis. These shocks will be scaled in subsequent analysis to consider the effects of tail events that are multiple standard deviations large. The unit standard deviation idiosyncratic or systematic shock at each of the CCPs in the sample are depicted with the colored bars in the figure. The figure also provides context for interpreting the size of multiple standard-deviation shocks. While the boxplots below the colored bars are not used in the subsequent analysis, they provide context on the plausibility of tail events. They depict the size of extreme-but-plausible stress scenarios considered in different kinds of stress testing at the CCPs. Comparing the colored bars with the boxplots suggests that some tail events, although many standard deviations outside the norm, may in fact be more plausible than appearances and therefore deserve careful consideration.

Our calibrated shocks are depicted as follows. The dark blue bars in the first two rows both represent, for an average quarter, the maximum aggregate daily VM call. Note that the dark blue bars are equal by construction. The light blue bar is our measure of a unit idiosyncratic shock; it represents the additional maximum aggregate daily VM call at a particular CCP in a quarter where the shock is one standard deviation above the norm for that CCP. The green bar is our measure of a unit systematic shock; it represents the additional maximum aggregate daily VM call at a particular CCP in a quarter where the common shock component across all CCPs is one standard deviation above the norm. For a given CCP, the green bar is less than the light blue bar which reflects the fact that the green bar only reflects quarterly variation in the CCP's maximum aggregate daily VM call that loads on a common component across all CCPs in the sample.

Below the calibrated shocks, we depict five measures of aggregate VM calls at each CCP.

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[7] The OCC does not report average or maximum VM calls in its quarterly PQD filings, which makes it impossible to construct idiosyncratic or systematic shocks for this CCP directly. We rely on a second-best approach in which we make our estimates for the other CCPs and then scale up the shocks to ICUS by a factor of ~7. We use ICUS as a comparison because it is US-based and clears F&O, like OCC. We choose a factor of 7 based on the relative size of IM top-up calls, which is a statistic that both ICUS and OCC report.

- We plot the average and maximum aggregate daily VM calls at each CCP for the sample of quarters reported in the PQDs. The maximum aggregate daily VM calls are used to construct our unit shocks and the blue bars, which represent series averages, fall within the series' ranges. Our analysis proceeds first by considering the most extreme aggregate VM call in an ordinary quarter; the average aggregate VM call provides context for margin demands on an ordinary day in that quarter.
- We plot CCP estimates of cover-1 losses, also from the PQDs. Under a cover-1 standard, CCPs must retain enough pre-funded resources to cover losses associated with the default of the single largest CM under extreme but plausible circumstances.[8] An estimate for the size of these losses is the VM obligations accruing to a single member's portfolio over the margin period of risk (MPOR), i.e. the time it would take the CCP to close out the member's positions. CCPs report modeled ex-ante estimates (C1 Est) of such a change in portfolio value in the upcoming quarter as well as ex-post realizations (C1 Act) of the largest such change in a member's portfolio value over the prior quarter.[9] Note that, relative to our benchmark shocks, the cover-1 estimates consider VM demands on a single market participant rather than all participants, but allows these obligations to accrue over multiple days (the MPOR) rather than measuring only the first day of losses. In many instances, and particularly at JSCC and LCH SA, these Cover-1 estimates are many multiples of our unit shock, suggesting that tail events many standard deviations above the norm deserve careful consideration.
- In the final box of the figure, we use data from Y-14Q Schedule L to report the aggregate VM across reporting institutions under the severely adverse scenario in the Dodd-Frank Annual Stress Test (DFAST) framework. We can estimate VM flows at the clearing member level because clearing members report the change in value of their portfolios under a hypothetical shock in the Y-14Q data. Relative to our benchmark shocks, the DFAST VM considers only a subset of market participants (only the US G-SIBs). Moreover, the DFAST estimates correspond to hypothetical annual shocks, not those that have been observed historically. In several cases, for example at CME and ICE EU, these estimates represent many standard deviations of our unit shocks, again drawing attention to tail events.

[8] Many of the CCPs in this sample are subject to a cover-2 standard, for which they must retain sufficient prefunded resources to cover losses from the largest two clearing members should they default in "extreme-but-plausible" circumstances. The data reported in the PQDs, however, speaks only to the cover-1 benchmark and is therefore even lower than resource burdens considered in supervision.

[9] Recall that losses in portfolio value imply VM obligations but not necessarily default losses because members may, and almost always do, make timely VM payments. The estimate is intended to inform the resources that would have been required if the member had counterfactually defaulted on such an obligation.

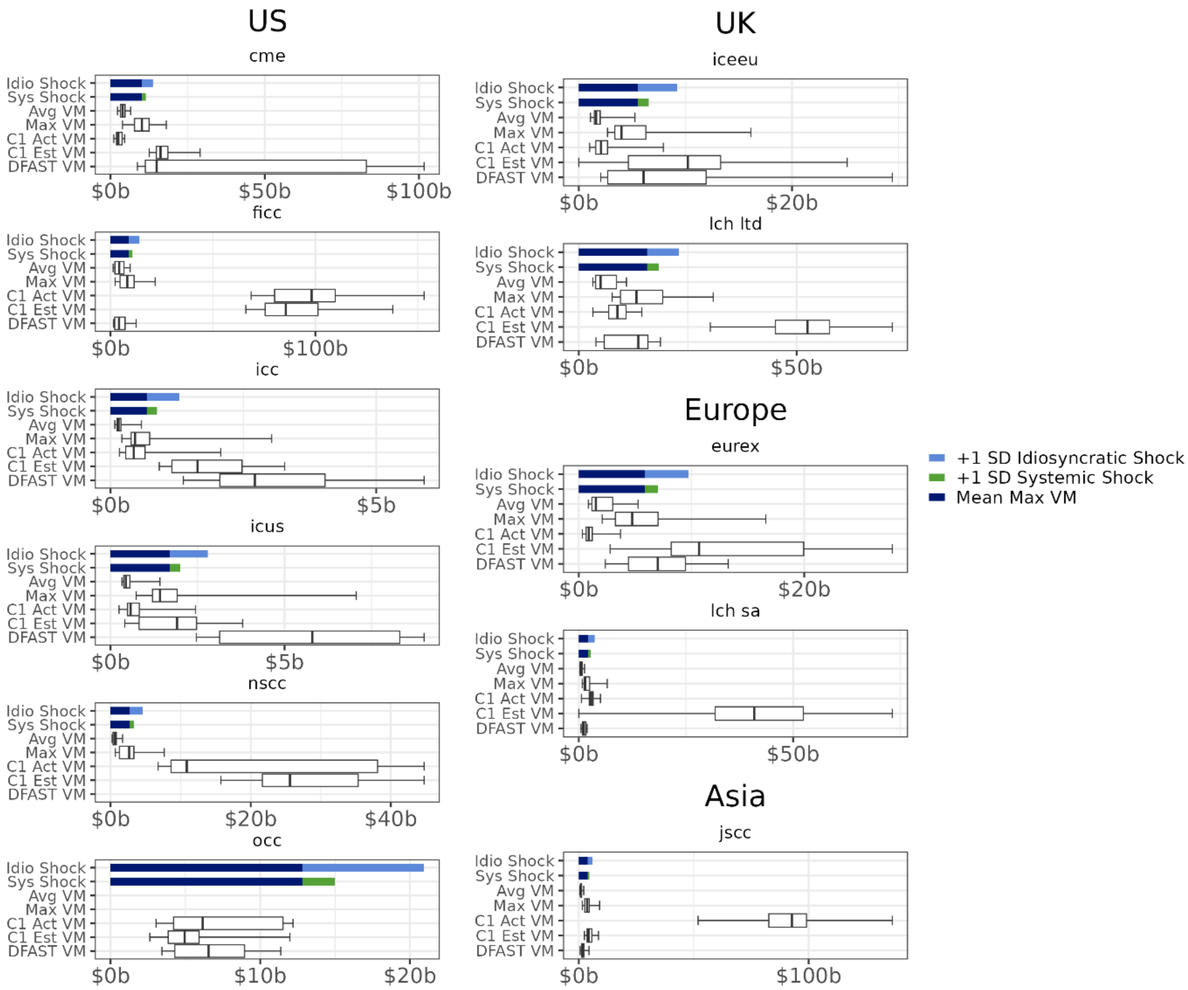

Figure 5. Size of shocks under different scenarios. For each of the 11 CCPs sorted by region, where data are available, we plot the size of the calibrated shocks used in the analysis (Idio Shock, Sys Shock). Below these are box-and-whisker plots of average quarterly VM calls (Avg VM), maximum quarterly VM calls (Max VM), cover-1 estimated (C1 Est VM) and realized (C1 Act VM) exposure, and hypothetical VM calls implied under the DFAST severely stressed scenario on the CMs in our sample (DFAST VM). The box plots correspond to the p25, median, and p75 for the corresponding series; the whiskers correspond to the min and max except in the case of DFAST VM, for which they correspond to p10 and p90.
Note: The calibrated shocks for OCC are scaled from those at ICUS according to data on maximum quarterly IM top-ups because data on quarterly VM calls at OCC are not available in the PQDs. Certain data points (e.g. NSCC, DFAST VM min and max) are masked to avoid possible disclosure of proprietary information of individual FR Y-14Q filers.
Source: Clarus FT CCPView, FR Y-14Q Schedule L, Authors' analysis

From Shocks to CCP Demands

During episodes of stress, CCPs may place demands on CMs in several ways. First, a CM may have to meet VM obligations because of losses in their account with the CCP. Second, stress may increase volatility, leading the CCP to demand additional IM to support the CM's position. Third, a default by another CM may require additional resources from surviving CMs to replenish any losses to the DF, as well as to satisfy any assessment calls by the CCP.

These different resource demands may be characterized as liquidity or capital demands (see ***Figure 6***). Capital losses are those that, from the perspective of the CM, cannot be recovered. Liquidity demands refer to resources that the CM must provide to the CCP promptly. VM calls and assessment calls represent both capital losses and liquidity demands to the CM as they must both transfer and forfeit these resources. Of these, VM calls represent "direct" capital losses as they are losses on a CM's positions whereas the assessment calls are "indirect", as they stem from the default of another CM. Losses to the DF represent capital losses to the CM as they are forfeited but are not liquidity demands because they do not need to be transferred. Contributions to replenish the DF and IM top-ups, by contrast, are liquidity demands because they must be transferred, but not capital losses because they can be recovered in the future if, for example, the CM chooses to wind down its own, or its clients' positions with the CCP.

Our analysis focuses on indirect capital losses and liquidity demands, i.e. IM top-ups, DF losses and replenishment, and assessment calls. Substantively, these are demands that all lie outside the control of the CM. While we do not consider VM losses in the CM's own account, we note that our measures of CM stressed capital and stressed liquid resources include notions of VM losses – further inclusion of VM losses would be, to some extent, redundant. Our estimates may be somewhat conservative as a result. As a practical matter, it is unclear how to apportion hypothetical VM shocks among different CMs, given the variety with which shocks may arise.

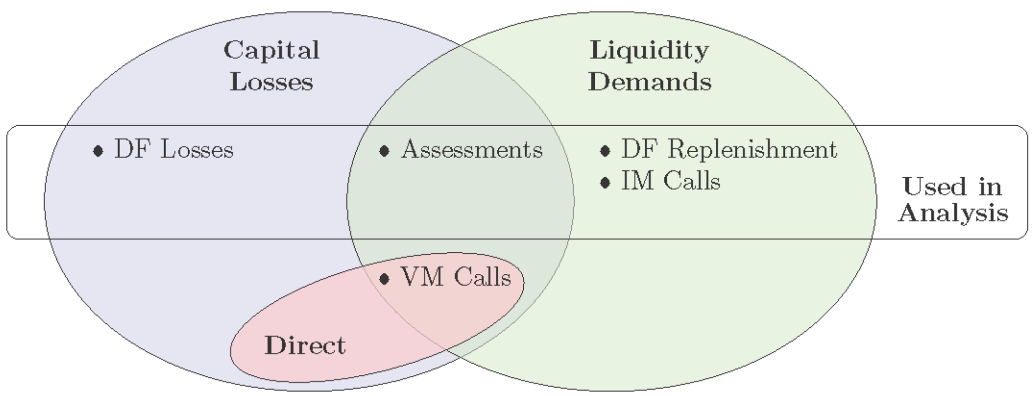

Figure 6. Summary of Resource Demands under CCP Stress
Source: Authors' creation

To translate our VM shocks into resource demands, we estimate the effect of VM shocks on aggregate exceedances, i.e., cases where VM exceeds IM, and aggregate IM top-up calls in the data. For a given CCP, c, and scenario, s, we assume the following functional forms:

$$log\frac{EXCD_{cs}}{PRF_c} = \alpha + \beta * \frac{VM_{cs}}{PRF_c} + \varepsilon \tag{1}$$

$$\frac{\Delta IM_{cs}}{PRF_c} = 0 + \mu * \frac{VM_{cs}}{PRF_c} + \varepsilon \tag{2}$$

where PRF corresponds to prefunded resources, EXCD to exceedance volume, VM to variation margin and ΔIM to IM top-up.

To estimate these relationships, we rely on data from the PQDs. For each CCP, we obtain quarterly data on the maximum quarterly VM, maximum IM top-up call, and aggregate quarterly exceedance volume over all accounts. We use an algorithm to extract quarterly exceedance volume from a reported series of aggregate annual exceedance volumes – see ***Appendix A***: Methodology for Estimating Quarterly Exceedance Flows. Where these series are reported at the service level, we sum across services to get an aggregate value for the CCP.

We note that exceedances do not necessarily imply a default, or a loss to the CCP. To estimate potential losses, we assume that exceedances coincide with defaults.[10] We attribute the entire exceedance amount to a loss – first to the CCP's skin-in-the-game and then to the DF. [11]

Finally, we distinguish between for-profit and not-for-profit CCPs, essentially contrasting FICC and the NSCC to others. We do this because FICC and NSCC use a single clearing fund with mutualized resources. The efficiency of mutualized resources in addressing shortfalls means smaller aggregates are required. This makes comparisons of for-profit and not-for-profit CCPs more difficult.

Adopting the functional forms in Equations (1) and (2) has several advantages. First, these functional forms roughly reflect the data in the PQDs. When scaling all variables by prefunded resources, logged exceedances appear linear in VM shocks, whereas unlogged IM calls appear linear in VM. Second, these functional forms reflect theoretically sensible properties. We fix the intercept of the IM-call relation to zero on the notion that in the absence of a volatility shock that affects VM, there will be an increase to IM. It is also reasonable to assert that exceedances are convex in VM shocks because accounts facing VM demands are initially covered by their IM, as the size of the VM shock increases, IM is used up and VM demands load on exceedances. Finally, specifying the relationships in this way facilitates estimation. By assuming a common relationship across CCPs, we can pool quarterly observations to develop an estimate that is less subject to sampling bias.

Figure 7 illustrates the results of this analysis among for-profit CCPs in the panels on the left and among not-for-profit CCPs in the panels on the right. The upper panels depict the relationship between IM top-ups and VM; the lower panels depict exceedances and VM. We note that, comparing the figures, there is

[10] The clearing members we consider are large banks that function primarily as intermediaries in the short-term funding and derivatives markets of interest. These dealer banks therefore very often have taken positions in the bilateral market that offset their positions with CCPs. When VM calls are made, the dealers expect to receive offsetting VM payments from their bilateral contracts. One way to think about our assumption that exceedances prompt default losses is to suppose that these bilateral counterparties default in the shocked state of the world, and that these default losses spill over through the large CMs examined here to the CCP.

[11] We note that this allocation overestimates the demands on surviving clearing members when exceedances are small enough so that they do not exhaust the DF. In that case we would need to first account for the DF contribution of the defaulting member – information that is not available to us. Once the exceedance is large enough to exhaust the CCP's SITG and the mutualized resources in the DF, our estimates are accurate reflections of the demands on the surviving clearing members. For a similar reason, unless the exceedance is large enough to exhaust the CCP's assessment powers, not accounting for the identity of the defaulting member, leads to an underestimate of the potential assessments on the surviving members. Our approximation is reasonable in the cases where both CCPs and clearing members face significant stress – these cases are the focus of our analysis.

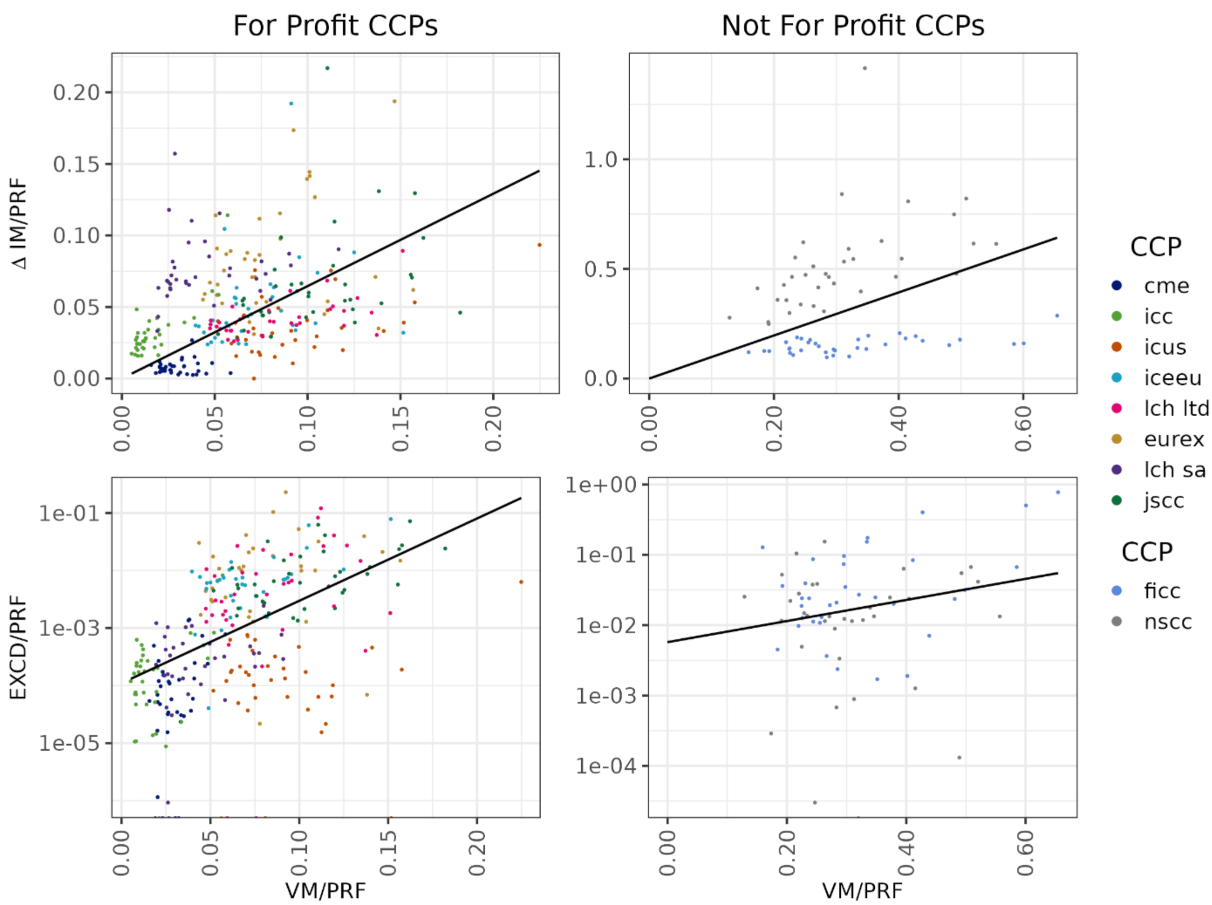

Figure 7. IM Top-ups and Exceedances vs. VM Shock. The upper panels show IM Top-up calls relative to total prefunded resources versus maximum VM calls relative to total prefunded resources (ΔIM/PRF). The lower panels show exceedance volumes relative to total prefunded resources versus maximum VM calls relative to total prefunded resources (EXCD/PRF). Panels on the left correspond to for-profit CCPs (CME, ICC, ICUS, ICE EU, LCH Ltd., Eurex, LCH SA, JSCC); panels on the right correspond to not-for-profit CCPs (FICC, NSCC). Exceedance scale in logs.
Source: ClarusFT CCPView, Authors' analysis

a clear difference in slopes between the types of CCPs. Our approach comes with several caveats. First, it is possible that IM calls are convex. For example, if there are anti-procyclicality measures in place, we would expect small IM calls in response to VM shocks because of the benefits of excess pre-positioned IM.[12] However, with sufficiently large VM shocks, excess IM would be exhausted, and further IM top-ups would have to resume according to a standard schedule. We do not see evidence of this occurring in the data, so we simply leave out this effect. In general, it would only serve to make our results more pronounced.

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[12] In periods of elevated stress and volatility, CCPs may make additional IM calls to ensure sufficient resources in the event of member default, with the unintended consequence of further contributing to stress by straining the liquid resources of members. Thus, their IM calls are procyclical in nature. Anti-procyclicality measures seek to mitigate the need for such margin calls in times of stress by increasing IM demands in ordinary times beyond what would be justified by, for example, contemporary levels of volatility.

Second, we would not expect exceedances to grow faster than VM in general. This is because for every additional dollar of VM obligation in an account, this will either be covered by IM or else show up as an exceedance. To address this concern, when extrapolating our estimates of exceedances for large VM shocks, we modify the functional form of the relationship between exceedances and VM, so the slope remains 1 once it reaches 1.

Third, we would expect exceedances to be zero when VM shocks are zero. While this is not captured in the functional form, our estimates of the intercept are nevertheless very close to zero.

Finally, in our estimation, we rely on quarterly aggregate exceedances. It may be appropriate to include some exceedance volumes accruing to the CCP in the days immediately after the maximum VM shock because, in a default scenario, these could constitute default losses. However, this is not generally true of all exceedance volumes in the quarter, and, for this reason, our approach might overstate exceedance volumes.

From CCP Demands to CM Resources

Having established stress scenarios and estimated the aggregate IM top-up calls and exceedances of the CCP, we estimate the impact on the CMs. We are interested in how well CMs are prepared to meet the liquidity demands and absorb the capital losses associated with the stress at the CCP. For a given CM, b, CCP, c, and scenario, s, we measure the utilization of the CM's liquid and capital resources as:

$$Utilization_{\mathrm{bcs}} = \frac{Demands_{bcs}}{Resources_{b}} \tag{3}$$

where Demands refers to liquidity demands or capital losses at the CM level and Resources refers to the availability of capital or liquid resources at the CM.

We allocate aggregate CCP resource demands to individual CMs on a pro-rata basis. We apportion the aggregate IM top-ups according to the level of IM for each CM:[13]

$$\Delta im_{bcs} = \frac{\mathrm{im_{bc}}}{\mathrm{IM_c}} * \Delta IM_{cs} \tag{4}$$

where im_{bc} is the IM of CM b at CCP c, IM_c is the aggregate IM at CCP c, ΔIM_{bcs} is the IM top-up for surviving CM b at CCP c under scenario s, and ΔIM_{cs} is the aggregate IM top-up for surviving members at CCP c under scenario s.

We calculate losses to the DF and associated levels of replenishment and assessments based on the relationship between the maximum VM and exceedance. For a scenario with a given level of maximum VM, we estimate the corresponding exceedance level, assume that accounts with exceedances default, and allocate the exceedance amount first to the CCP's skin-in-the-game and then to the DF. If the remaining exceedance amount is larger than the DF, then we proceed to allocate additional losses based

[13] We note that this calculation only adjusts the IM for the house accounts of each clearing member. Client accounts have their own IM, and we assume that any additional margin for client accounts will be covered by additional funds provided by the clients.

on the CCP's assessment powers. All losses, assessments, and the replenishment of the DF, are distributed across CMs on a pro-rata basis based on their DF contributions:[14]

$$\mathrm{Assess_{bcs}} = \frac{\mathrm{df_{bc}}}{\mathrm{DF_c}} * \mathrm{ASSESS_{cs}} \tag{5}$$

where $Assess_{bcs}$ is the assessment towards surviving CM b at CCP c under scenario s, df_{bc} is the default fund contribution of CM b at CCP c, DF_c is the aggregate size of the default fund at CCP c, and $ASSESS_{cs}$ is the aggregate assessment for surviving members at CCP c under scenario s.

[14] If the exceedance is so large that both the DF and the CCP's assessment powers are exhausted, we apportion additional losses to surviving CMs on a pro-rata basis based on their DF contributions.

Results

We evaluate CCP demands against the stressed resources available to the CMs. That is, following equation (3), we compute the potential utilization of CMs' stressed liquid and capital resources.

Scenario 1: Idiosyncratic Shocks

The first case we consider is an idiosyncratic shock. In ***Figure 8***, we depict the resource demands that each CCP would – separately – impose on its clearing members. The horizontal axis represents the size of a hypothetical shock, measured in standard deviations of maximum VM calls at each CCP. The vertical axis measures resource utilization at the average CM in our sample, that is the level of resource demands on the CM divided by their available stressed resources. ***Figure 8a*** depicts utilization of liquid resources and ***Figure 8b*** depicts utilization of capital. For example, where the colored vertical bars total 5% on the vertical axis, the CMs in our sample would, on average, experience a 5% utilization of their available stressed resources.

The different colored vertical bars depict the different kinds of resource demands that a CCP might place on its clearing members. Considering a (highly unlikely) 30 standard deviation shock[15] at ICC, for example, we can see that the CCP IM call would use, on average, 1% of CM liquid resources (the dark blue bar), an assessment call to replenish the depleted DF would take another ~0.5% of CM liquid resources (the light blue bar), and a further assessment call to cover losses in excess of the DF would take yet another ~0.5% of CM liquid resources (the green bar). There would still be uncovered losses remaining and it would be necessary to cover them for clearing activity to resume as normal. If shared pro-rata among CMs, these would account for still a further ~0.5% of liquid resources (the orange bar).[16] In total, then, such a shock would take up roughly 2.5% of CM resources.

The figure provides additional context for interpreting the plausibility of tail events. Specifically, we compare the shock in the horizonal axis – measured in number of standard deviations of the maximum aggregate VM above the mean value – to other observed shocks where the VM value is known. The fist shock, represented by the vertical dashed line reflects the maximum aggregate daily VM shock in 2020 Q1, the onset of the Covid-19 pandemic - VMs during that time averaged between 6-10 times the observed VM averaged over other quarters. The grey horizontal bars in the upper left of the figures depict VM ranges for the reported maximum aggregate VM, the Cover-1 stress tests, and the DFAST severely adverse scenario for the six CMs in our sample. In some cases, the magnitude of these hypothetical shocks corresponds to a shock many standard deviations above the norm.

The figures show that clearing members have sufficient resources to withstand large shocks and large demands by the CCPs, even when they themselves are stressed. At the same time, the demands are significant, especially relative to the level of liquid resources available to clearing members. The figures

[15] The figures show 35 standard deviation shocks for each CCP. Though these tail-of-tail events are unlikely we include them in the analysis for two reasons. First, large standard deviation resource demands occasionally show up in DFAST or Cover-1 stress testing. We aim to consider scenarios at those extremes. Second, we adopt the standard deviation as a unit of measure for stress size in part to have a natural comparison across different CCPs. While the likelihood distribution of extreme scenarios is difficult to state with confidence, we still aim to understand the differing experiences of CCPs under comparably extreme stress.

[16] In practice, additional losses at a CCP would be passed to the CMs through end-of-the-waterfall procedures specific to each CCP, such as variation-margin-gains-haircutting or contract tear-up.

also show that, for moderate shocks, the demands are largely due to increases in the IM. It is only for the largest shocks that demands due to defaults and DF losses become material.

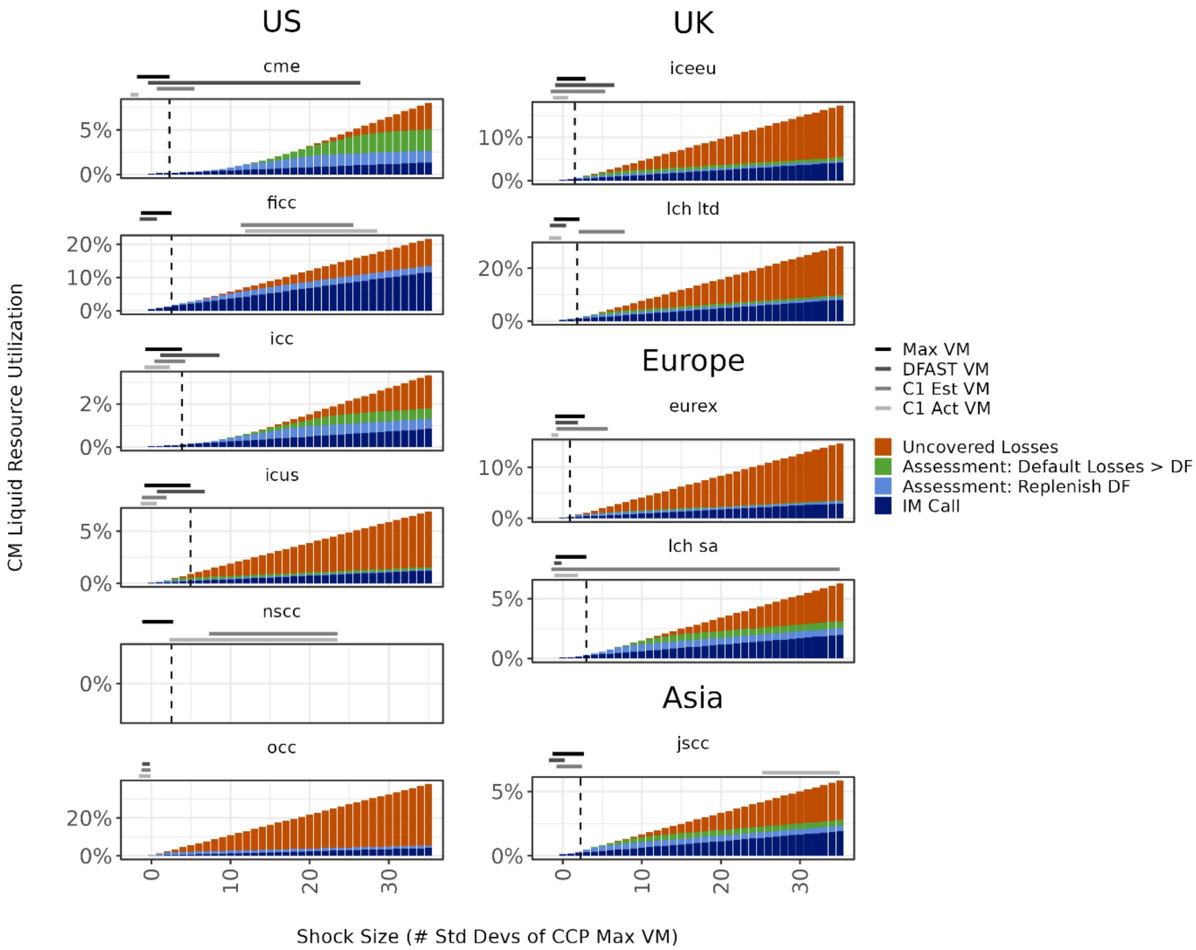

Figure 8a. Liquidity demands under idiosyncratic CCP stress scenarios. Each panel shows liquid resource utilization for the average CM, i.e. the fraction of stressed CM resources used in an idiosyncratic shock of increasing size, measured in the number of standard deviations above the mean maximum quarterly VM call at the CCP. Each panel depicts the results of shocks to a different CCP. The colored bars indicate the total utilization of resources from different sources: IM calls (dark blue), assessments to replenish the DF (light blue), assessments to cover losses in excess of the DF (green), and losses in excess of assessment powers (orange). The shock sizes are contextualized by the range of maximum quarterly VM calls (Max VM), implied VM under the DFAST severely stressed scenario (DFAST VM), and cover-1 estimates and realized exposures (C1 Est VM, C1 Act VM). The vertical dashed lines indicate the maximum aggregate VM call at the CCP in Q1 2020.
Note: C1 Est VM at LCH SA extends to 47 and C1 Act VM at JSCC to 70 but truncated at 35 for ease of plotting. Certain data points (e.g. NSCC, DFAST VM min and max) are masked to avoid possible disclosure of proprietary information of individual FR Y-14Q filers.
Source: ClarusFT CCPView, DFAST Disclosures, FR Y-14Q Schedule L, LCR Disclosures, Authors' analysis.

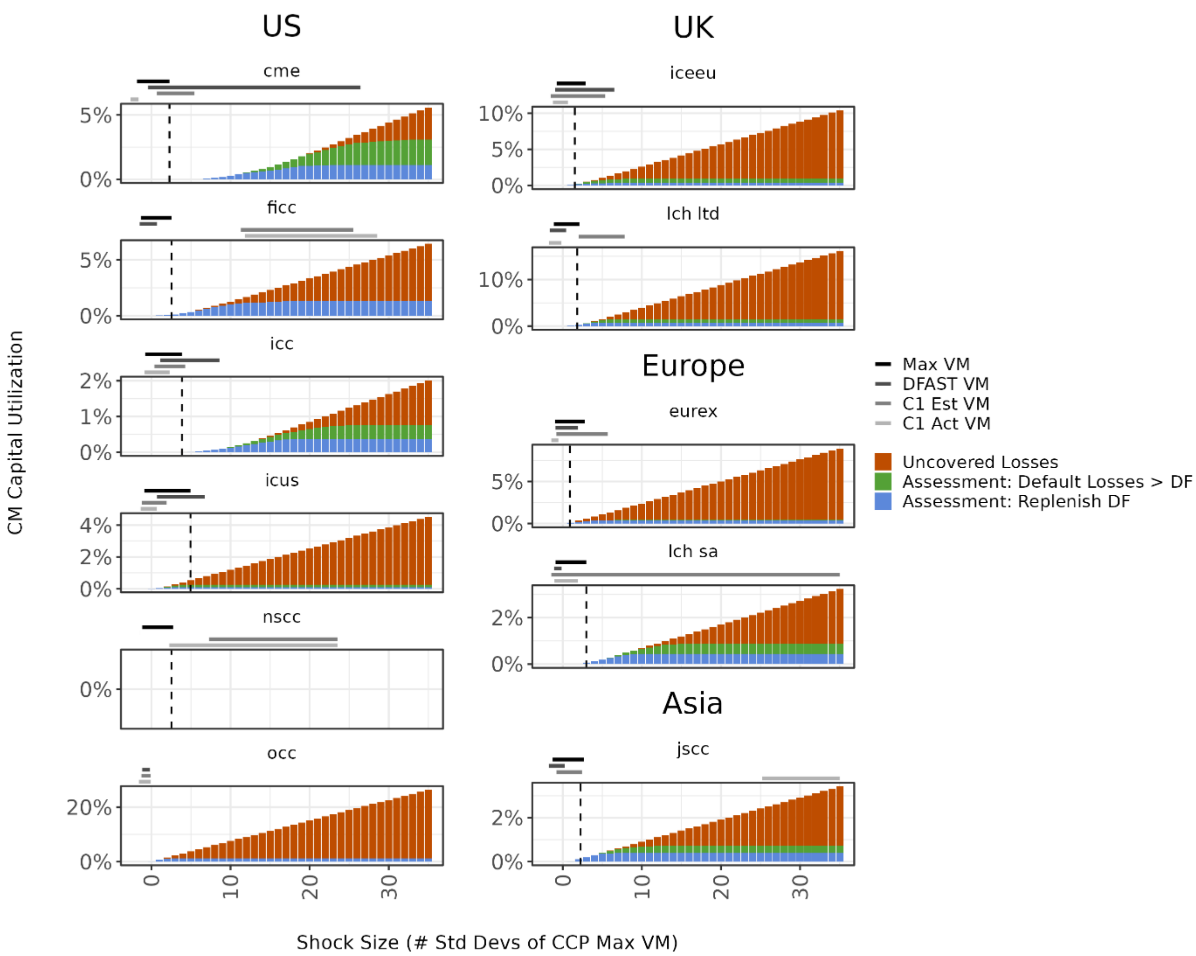

Figure 8b. Capital demands under idiosyncratic CCP stress scenarios. Each panel shows liquid resource utilization for the average CM, i.e. the fraction of stressed CM resources used in an idiosyncratic shock of increasing size, measured in the number of standard deviations above the mean maximum quarterly VM call at the CCP. Each panel depicts the results of shocks to a different CCP. The colored bars indicate the total utilization of resources from different sources: IM calls (dark blue), assessments to replenish the DF (light blue), assessments to cover losses in excess of the DF (green), and losses in excess of assessment powers (orange). The shock sizes are contextualized by the range of maximum quarterly VM calls (Max VM), implied VM under the DFAST severely stressed scenario (DFAST VM), and cover-1 estimates and realized exposures (C1 Est VM, C1 Act VM). The vertical dashed lines indicate the maximum aggregate VM call at the CCP in Q1 2020.
Note: C1 Est VM at LCH SA extends to 47 and C1 Act VM at JSCC to 70 but truncated at 35 for ease of plotting. Certain data points (e.g. NSCC, DFAST VM min and max) are masked to avoid possible disclosure of proprietary information of individual FR Y-14Q filers.
Source: ClarusFT CCPView, DFAST Disclosures, FR Y-14Q Schedule L, LCR Disclosures, Authors' analysis

Scenario 2: Systematic Shock

Figure 9 depicts the results of a systematic shock. The horizontal axis represents the size of the systematic shock, measured in standard deviations of the first principal component. The vertical axis is the utilization of the average CM's liquid and capital resources due to simultaneous stress across all major CCPs. The horizontal axis represents the number of standard deviations of the first principal component of maximum VM across CCPs. These scenarios translate to VMs at each CCP equal to the average maximum VM for that CCP plus a value based on the loading of that CCP's maximum VM on the first principal component. These VMs correspond to demands for resources from clearing members based on the relationships between VM and additional IM as well as VM and exceedance at each CCP. We analyze a case where exceedances correspond to losses, i.e., when VM more than IM prompts clearing member default.

The results are like those for the idiosyncratic shocks: the average CM has sufficient resources to withstand large shocks and large demands by the CCPs, even when they themselves are stressed, but the demands are significant, especially relative to the level of liquid resources available to clearing members.

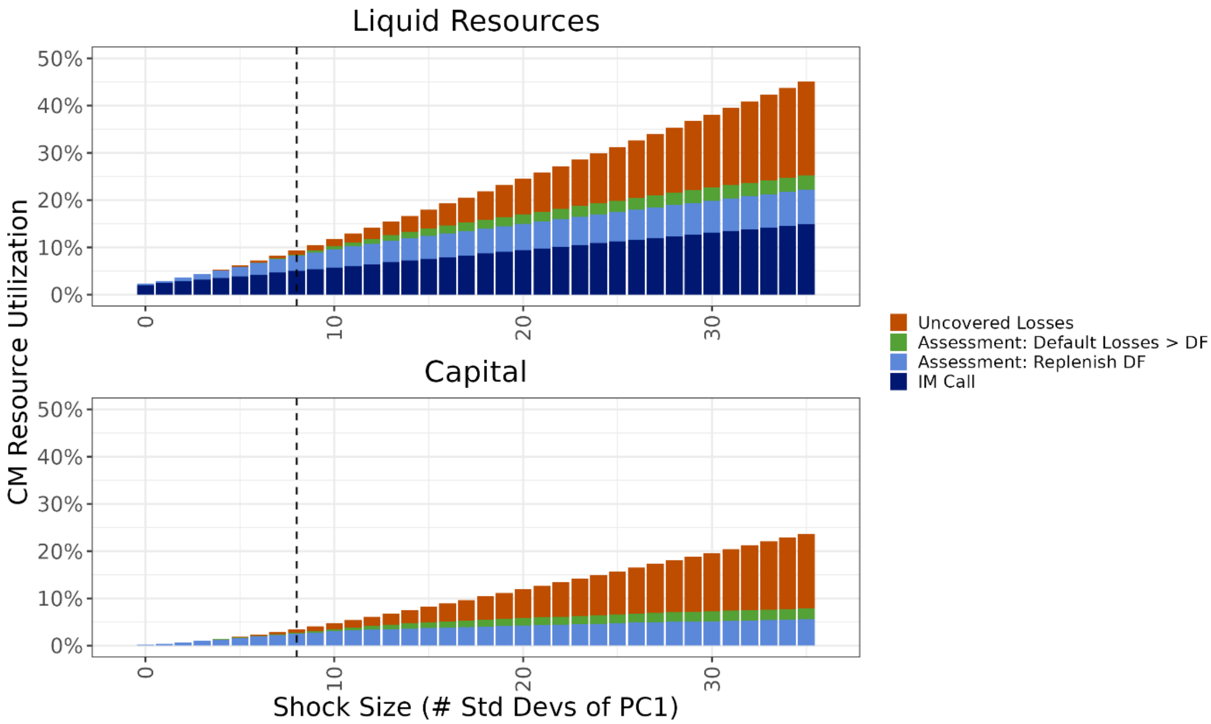

Figure 9. Resource utilization under systematic CCP stress. Each panel shows resource utilization for the average CM, i.e. the fraction of stressed CM resources used in a systematic shock of increasing size, measured in the number of standard deviations of the first principal component. The upper panel depicts capital utilization; the lower panel depicts utilization of liquid resources. The colored bars indicate the total utilization of resources from different sources: IM calls (dark blue), assessments to replenish the DF (light blue), assessments to cover losses in excess of the DF (green), and losses in excess of assessment powers (orange). Resource demands on the clearing members are totaled across all CCPs as the shock is a systematic shock affecting all CCPs simultaneously. The vertical dashed line indicates the size of the systematic shock to CCPs in Q1 2020.
Source: ClarusFT CCPView, DFAST Disclosures, FR Y-14Q Schedule L, LCR Disclosures, Authors' analysis.

Scenario 3: Reverse Stress Test

We consider a third and final scenario in which each CCP faces a shock large enough to exhaust its assessment powers. That is, for each CCP, we conduct a reverse stress test where the size of the shock is calibrated such that the implied exceedances not only exhaust the DF but also require use of all default loss assessment powers.[17] For such a shock, we estimate the size of the associated IM top-up call. Then we examine the utilization of CMs' available liquid and capital resources. While such a shock is unlikely, it is useful because it provides an upper bound to the resource demands CCPs could place on their CMs.

For the average CM, the size of resource demands, aggregated across all CCPs, relative to stressed liquid assets is depicted in the upper panel of ***Figure 10*** and relative to stressed capital in the lower panel. The frequency of the data in the two panels differs because estimates of stressed bank capital are available less frequently than stressed liquid resources. Liquid resource utilization ranges from 15-35% while capital resource utilization ranges from 10-15%. Clearing members have sufficient resources to handle such a stress scenario.

Liquid resource utilization has increased appreciably in the past seven years. This increase is not the result of changing estimates of liquid assets available under stress per the LCR; these series have remained stable. The change does not appear to have been a consequence of Covid; though liquid resource demands experienced a pronounced increase in 2020 Q1, these did not persist. The rise appears to be related to the potential for IM top-ups under stress, which has risen gradually over time.

The modest average level of potential utilization masks considerable heterogeneity. One standard deviation above the mean reaches above 50% utilization of liquid resources in 2024 Q1 and above 25% utilization of capital in 2017 Q4. As a reference, for six observations of normally distributed data, on average, roughly one in six would lie at or above the one standard deviation mark. The differences across CMs have largely declined since 2018 but have increased somewhat in recent quarters.

The extent to which CCP demands deplete the balance sheet resources of their clearing members depends on whether the clearing members are experiencing stress at the time the CCP makes its capital calls. The increase in potential utilization of CM resources in our sample indicates how much it matters that CMs themselves may be under stress independently. Specifically, utilization of CET1 capital increases from 7.8% when the average clearing member in our sample is not facing stress, to 11.7% when they are facing the severely adverse scenario in DFAST (see ***Figure 11*** Panel 1). On the other hand, the utilization under the LCR liquidity stress leads to an increase from 4.6% to 25.7% (see ***Figure 11*** Panel 1).

Rather than aggregating across all CCPs, panels 2 and 3 of ***Figure 11*** consider the demands from different subsets of CCPs. Specifically, Panel 2 considers individual CCPs, allowing for an evaluation of the significant of the demands of each, while Panel 3 considers the demands from the 3 largest – from the point of view of demands on their clearing members.

[17] We note that some of the shocks we consider in Scenarios 1 and 2 may be more extreme than the shocks in Scenario 3. Specifically, shocks in Scenario 3 are sized to exactly exhaust each CCP's assessment powers, while shocks in Scenarios 1 and 2 may result in losses beyond a CCP's assessment powers.

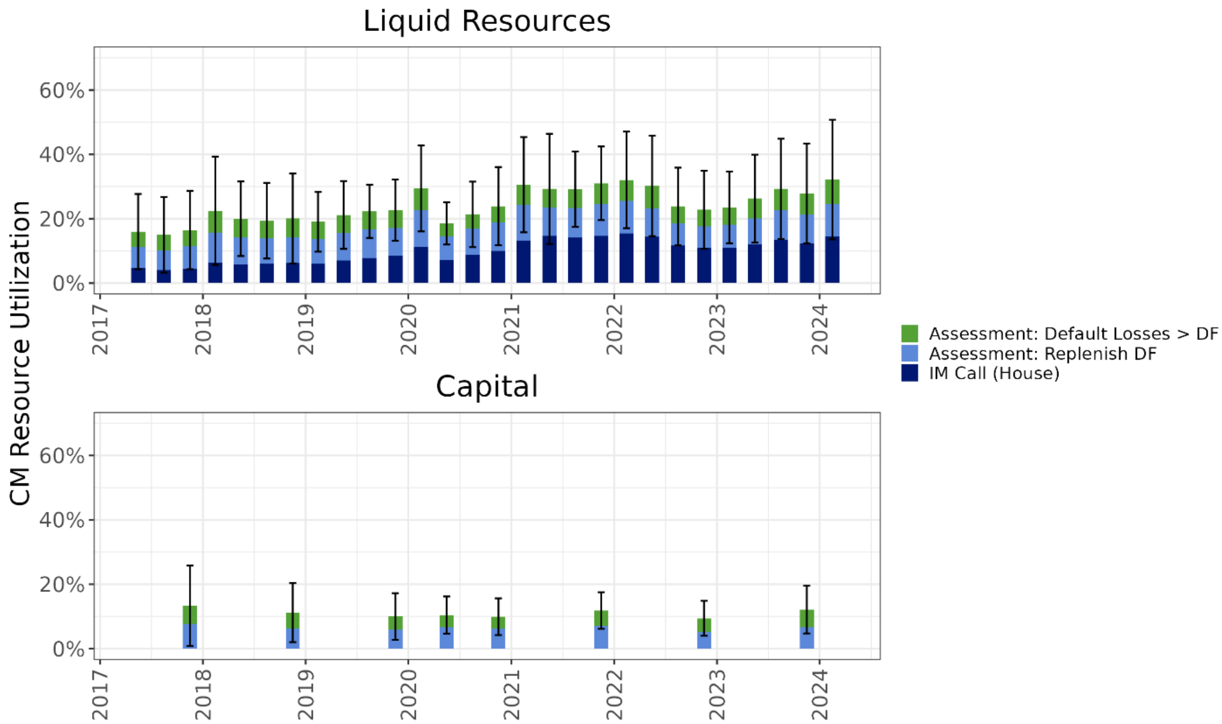

Figure 10. Resource Utilization under Reverse Stress Scenario. For an average CM, the upper panel shows utilization of stressed liquid resources (avg +/- std. dev.) Q2 2017 – Q2 2024; the lower panel shows utilization of capital (avg +/- std. dev.) Q4 2017 – Q4 2023.
Sources: ClarusFT CCPView, DFAST Disclosures, FR Y-14Q Schedule L, LCR Disclosures, Authors' analysis

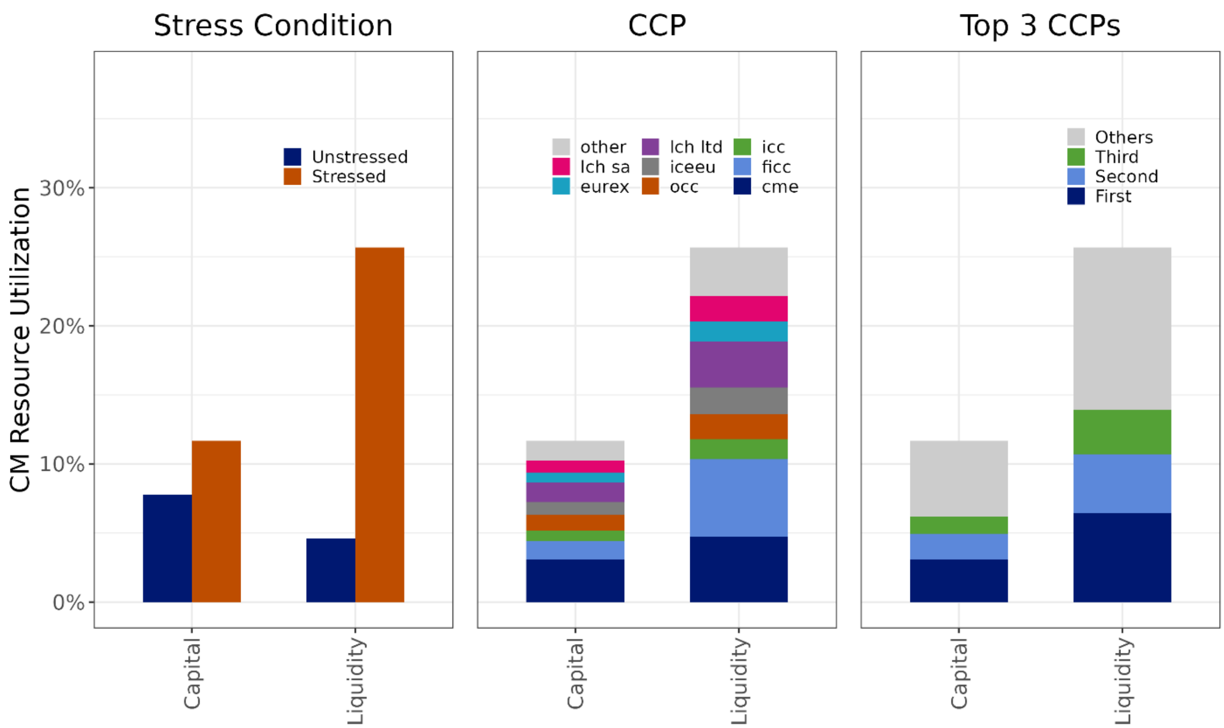

Figure 11. Utilization of Liquid Resources and Capital. The left panel describes aggregate liquid and capital utilization for the average clearing member when CM balance sheets are stressed (red) versus unstressed (dark blue). The middle panel depicts the composition of stressed liquidity and capital utilization for the average clearing member according to the CCP making the resource demands. NSCC, ICUS, and JSCC have been combined under "other" to prevent information disclosure on Y14Q reporting institutions. The right panel decomposes total stressed resource utilization according to the largest, second largest, and third largest CCP in any given quarter.
Sources: ClarusFT CCPView, DFAST Disclosures, FR Y-14Q Schedule L, LCR Disclosures, Authors' analysis

Conclusion

We consider six US G-SIBs, which are clearing members at major CCPs internationally and evaluate the impact that CCP demands may have on their capital and liquidity resources when both CCPs and clearing members face stress. We find that while the clearing members we consider have sufficient resources to meet CCP demands, the demands are significant. For example, our analysis reveals that, under a systematic shock sized at 10 standard deviations, CCP demands would use 8.8% of stressed CM liquidity and 2.2% of stressed CM capital, under the stress of the LCR and DFAST exercises respectively.

While our results are reassuring – CMs have sufficient liquidity and capital to withstand resource demands by CCP when both CCPs and CMs are under stress, there are caveats. We note that while the clearing members in our sample are among the largest clearing members, they account for only about 6-30% of CCP initial margins and 30-60% of default fund contributions. This analysis cannot speak to the reliability of CCP demands on other clearing members and could be improved with insight into their balance sheets, particularly under stress. The balance sheets of G-SIBs face heightened scrutiny so these smaller CMs may respond to capital calls under stress less reliably. The analysis also does not speak to demands on clients of the clearing members in our sample. The inability of clients to meet margin demands could impose additional obligations on their clearing members above those considered here or prompt selloffs otherwise contributing to heightened market stress. Finally, it is important to note that our shocks occur over a single day and may underestimate demands during periods of stress when the stress occurs over several days or weeks.

Given that the potential demands of CCPs are non-negligible, fluctuate over time, and exhibit considerable heterogeneity, continued monitoring remains valuable.

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Appendix A: Methodology for Estimating Quarterly Exceedance Flows

In the PQDs, CCPs report total exceedance volume over the past four quarters. In this paper, by contrast, we rely on estimates of the new exceedance volume during only the most recent quarter. We focus on exceedance volumes in the most recent quarter for two reasons. First, these are exceedances more plausibly associated with the VM shock during that quarter. Second, using annual exceedance volumes could potentially bias our estimates of the relationship between VM and exceedances downward. Consider a quarter with a large VM shock and large exceedance volume followed by several quarters of small VM shock and no new exceedance volume; there would appear to be no relationship between VM and exceedance volume when using the lagged measure.

There are two challenges to extracting information on the exceedance volume in the most recent quarter. First, because the time-series of four-quarter aggregates must begin somewhere, there is always missing information on the timing of exceedance volumes prior to the start of the series. Second, there appear to be obvious reporting errors in the reported series. For example, spikes that last a single quarter but do not persist for four quarters suggest that exceedance volumes are reported in the first quarter but not for the full year.

Our goal is to extract exceedance volume series in a manner that is intuitive, reproducible, estimates pre-series volumes, and accounts for what we deem to be obvious reporting errors in the PQD series.

(i) We consider the series of annual aggregate exceedance volumes reported in the PQDs as the evolution of a stock variable: $STOCK_t$. Each quarter, there is an addition of new quarterly aggregate exceedance volume, $INFLOW_t$, and a loss of stale exceedance volume no longer in the annual window, $OUTFLOW_t$. We note that we can write:

$$STOCK_{t-1} + INFLOW_t - OUTFLOW_t = STOCK_t \qquad (A1)$$

(ii) Our approach is to estimate a time-series of $INFLOW_t$ and $OUTFLOW_t$. Our $INFLOW_t$ series is from t = -3 to T and our $OUTFLOW_t$ series runs from t = 0 to t = T. Ultimately, we are interested in the value of $INFLOW_t$.

(iii) In an accurately reported series, the following properties hold:

$$INFLOW_t > 0 \qquad (A2a)$$

$$OUTFLOW_t > 0 \qquad (A2b)$$

$$STOCK_t - STOCK_{t-1} = INFLOW_t - OUTFLOW_t \qquad (A2c)$$

$$OUTFLOW_t = INFLOW_{t-4} \qquad (A2d)$$

(iv) We minimize the aggregate $INFLOW_t$ and $OUTFLOW_t$ series and penalize deviations from "accurate reporting properties" in (A2a-d). The penalty weights permit the algorithm to, for example, introduce a large outflow (contradicting A2d) provided that it rationalizes the evolving series of stocks (avoiding a penalty due to A2c).

Our selection of penalty terms is ad-hoc. However, it does a reasonably good job of extracting quarterly exceedance series from our data. In ***Figure 12***, we plot the results for the different CCPs and clearing services reported in the PQDs. The solid lines represent the original PQD data, or the "stocks"; the dashed lines represent the extracted data, or the "inflows". The dashed lines spike during the first quarter when the solid lines spike but then fall immediately. In quarters where the solid lines spike and then immediately fall, the dashed lines capture this behavior. Because our method is entirely embedded in code, it can be easily reproduced or modified.

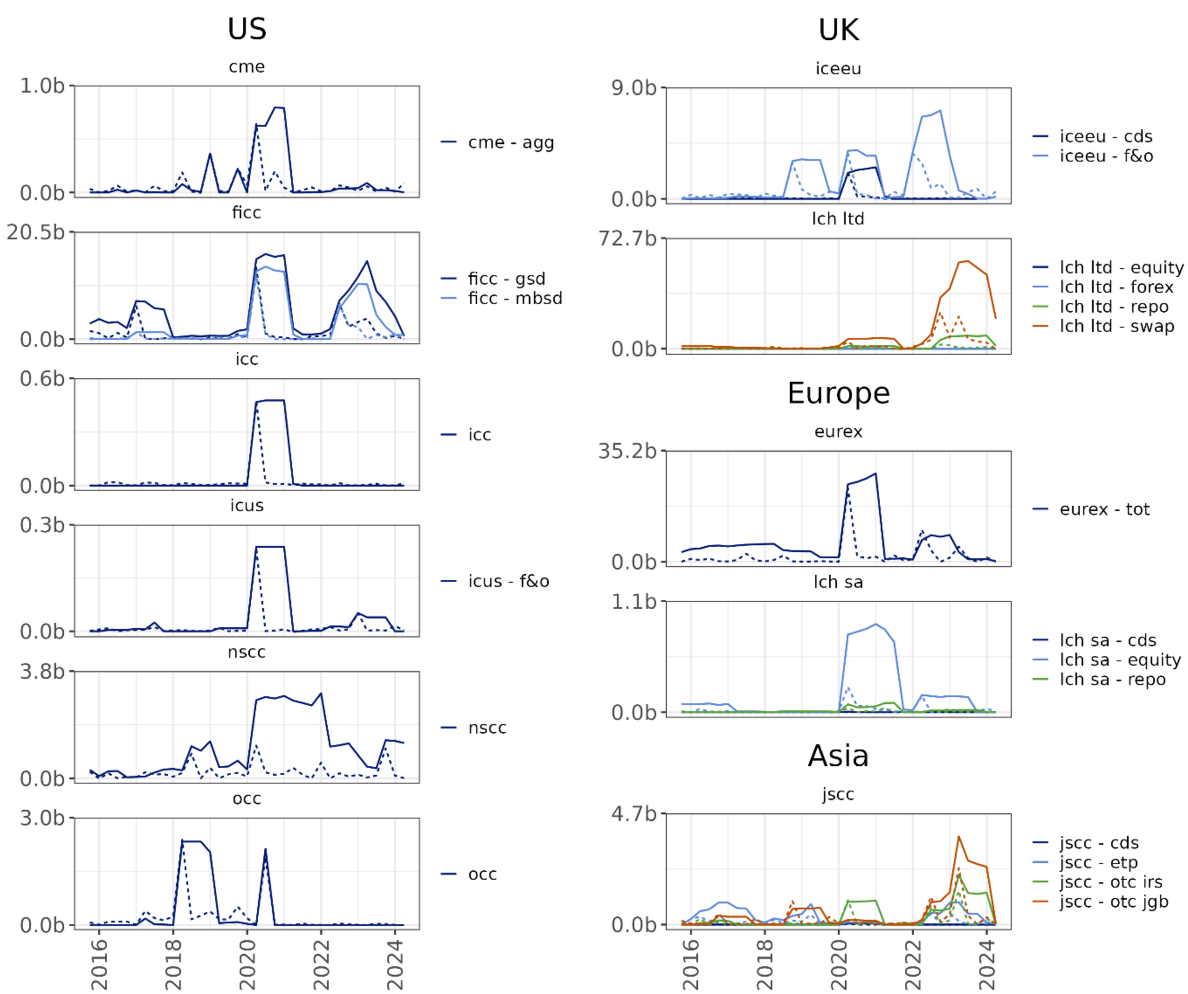

Figure 12. Annual vs Quarterly Exceedance Volumes. For each CCP in our analysis, the annual exceedance volumes for each CCP service are plotted in the solid lines. The quarterly exceedance volumes are estimated using an algorithm and plotted in the dashed lines.
Sources: ClarusFT CCPView, Authors' analysis