Bibliography of Legal and Economic Literature on Clearing and Central Counterparties[*†]

John Heilbron[‡]

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Abstract

The literature on financial market infrastructures (FMIs) and central counterparties (CCPs) is narrow, insular, somewhat interdisciplinary, and unpublished. For this reason, citations of interest are fairly dispersed. To help lower barriers to entry on this topic, I have compiled a (non-exhaustive) bibliography. Where available, I've included abstracts.

[*]The views and opinions expressed in this paper are those of the authors and do not necessarily represent official positions or policies of the OFR or the Department of the Treasury.

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[‡]U.S. Treasury, Office of Financial Research; John.Heilbron@ofr.treasury.gov.

References

Acemoglu, Daron, Asuman Ozdaglar, and Alireza Tahbaz-Salehi. Systemic Risk and Stability in Financial Networks. American Economic Review 105.2 (Feb. 2015), pp. 564–608. ISSN: 0002-8282. https://search.ebscohost.com/login.aspx?direct=true&db=eoh&AN=1471422&site=ehost-live&scope=site (visited on 01/25/2023).

This paper argues that the extent of financial contagion exhibits a form of phase transition: as long as the magnitude of negative shocks affecting financial institutions are sufficiently small, a more densely connected financial network (corresponding to a more diversified pattern of interbank liabilities) enhances financial stability. However, beyond a certain point, dense interconnections serve as a mechanism for the propagation of shocks, leading to a more fragile financial system. Our results thus highlight that the same factors that contribute to resilience under certain conditions may function as significant sources of systemic risk under others.

Acharya, Viral and Alberto Bisin. Counterparty risk externality: Centralized versus over-the-counter markets. en. Journal of Economic Theory. Financial Economics 149 (Jan. 2014), pp. 153–182. ISSN: 0022-0531. DOI: 10.1016/j.jet.2013.07.001. https://www.sciencedirect.com/science/article/pii/S0022053113001191 (visited on 03/29/2023).

We study financial markets where agents share risks, but have incentives to default and their financial positions might not be transparent, that is, might not be mutually observable. We show that a lack of position transparency results in a counterparty risk externality, that manifests itself in the form of excess "leverage," in that parties take on short positions that lead to levels of default risk that are higher than Pareto efficient ones. This externality is absent when trading is organized via a centralized clearing mechanism that provides transparency of trade positions. Collateral requirements and especially subordination of non-transparent positions in bankruptcy can ameliorate the counterparty risk externality in market settings such as over-the-counter OTC markets which feature a lack of position transparency.

Aldasoro, Iñaki, Fernando Avalos, and Wenqian Huang. Liquid assets at CCPs and systemic liquidity risks. BIS Quarterly Review (Dec. 2023).

Central counterparties CCPs are key players in financial markets, holding $1.3 trillion in liquid assets as of June 2023. The holdings are highly concentrated in the eight largest CCPs, mainly based in Europe and the United States. Most of these liquid assets are "cash" - ie deposits at central banks, reverse repos and unsecured bank deposits - and government bonds, which CCPs receive as collateral for the transactions they clear. This collateral improves systemic resilience by shielding CCPs from counterparty risk. But it also imposes liquidity demands on market participants that, occasionally, could worsen financial stress during flight-to-safety episodes or lead to destabilising margin spirals. The dual role of government bonds as both collateral and underlying assets for CCP-cleared derivatives introduces "wrong-way" risk that can exacerbate these spirals.

Allen, Julia Lees. Derivatives Clearinghouses and Systemic Risk: A Bankruptcy and Dodd-Frank Analysis. Stanford Law Review 64.4 (2012), pp. 1079–1108. ISSN: 0038-9765. http://www.jstor.org/stable/41511112 (visited on 06/19/2025).

This note analyzes the effectiveness of derivatives clearinghouses in decreasing systemic risk upon a counterparty default. The analysis first explains how a derivatives clearinghouse can successfully reduce systemic risk by analyzing LCH. Clearnet's management of the Lehman default in 2008. Next,

the analysis demonstrates that if a clearinghouse could not manage a default and became insolvent, systemic risk would greatly increase. Rather than containing the impact of a counterparty default, an insolvent clearinghouse would enhance systemic risk because the two existing resolution regimes, the Bankruptcy Code and the Dodd-Frank Orderly Liquidation Authority, could not successfully unwind the institution. The primary contribution of this Note is identifying that an insolvent derivatives clearinghouse creates an unsolvable problem with respect to resolution: untangling the derivatives trades will inevitably take more than a day, but if sorting out the portfolios takes even a few days, clearing members will start a run on the clearinghouse. The resulting enhanced systemic risk would necessitate government intervention. A major derivatives clearinghouse would be too big to fail. Accordingly, this Note proposes two recommendations to ensure that derivatives clearinghouses effectively reduce systemic risk. Regulators should: 1 *minimize the risk of clearinghouse insolvency through strict collateral, capital, and default management requirements, and* 2 *create an ex ante guarantee fund to serve as a government backstop and provide liquidity to an insolvent derivatives clearinghouse, thereby avoiding enhanced systemic risk.*

Amini, Hamed, Rama Cont, and Andreea Minca. Resilience to Contagion in Financial Networks. en. Mathematical Finance 26.2 (2016), pp. 329–365. ISSN: 1467-9965. DOI: 10.1111/mafi.12051. (Visited on 02/01/2023).

We derive rigorous asymptotic results for the magnitude of contagion in a large counterparty network and give an analytical expression for the asymptotic fraction of defaults, in terms of network characteristics. Our results extend previous studies on contagion in random graphs to inhomogeneous-directed graphs with a given degree sequence and arbitrary distribution of weights. We introduce a criterion for the resilience of a large financial network to the insolvency of a small group of financial institutions and quantify how contagion amplifies small shocks to the network. Our results emphasize the role played by "contagious links" and show that institutions which contribute most to network instability have both large connectivity and a large fraction of contagious links. The asymptotic results show good agreement with simulations for networks with realistic sizes.

Amini, Hamed, Damir Filipovic, and Andreea Minca. Systemic Risk and Central Clearing Counterparty Design. en. SSRN Electronic Journal 2275376 (Sept. 2015). DOI: 10.2139/ssrn.2275376. https://papers.ssrn.com/abstract=2275376 (visited on 03/27/2023).

We examine the effects on a financial network of multilateral clearing via a central clearing counterparty CCP from an ex ante and ex post perspective. The CCP is capitalized with equity and a guarantee fund and it can charge a volume-based fee. We propose a CCP design which improves aggregate surplus, and reduces banks' liquidation and shortfall losses. We characterize the CCP's equity, fee and guarantee fund policies that reduce systemic risk and are incentive compatible for banks. A simulation study based on aggregate market data shows that central counterparty clearing can reduce systemic risk and improve banks' utility.

Antinolfi, Gaetano, Francesco Carli, and Francesca Carapella. Transparency and Collateral: The Design of CCPs' Loss Allocation Rules. Finance and Economics Discussion Series 2019.0.58 (Aug. 2019). ISSN: 1936-2854. DOI: 10.17016/feds.2019.058.

This paper adopts a mechanism design approach to study optimal clearing arrangements for bilateral financial contracts in which an assessment of counterparty risk is crucial for efficiency. The economy is populated by two types of agents: a borrower and lender. The borrower is subject to lim-

ited commitment and holds private information about the severity of such lack of commitment. The lender can acquire information at a cost about the commitment of the borrower,which affects the assessment of counterparty risk. When truthful revelation by the borrower is not incentive compatible, the mechanism designer optimally trades off the value of information about the lack of commitment of the borrower withthe cost of incentivizing the lender to acquire such information. Central clearing of these financial contracts through a central counterparty (CCP) allows lendersto mutualize their counterparty risks, but this insurance may weaken incentivesto acquire and reveal information about such risks. If information acquisition isincentive compatible, then lenders choose central clearing. If it is not, they mayprefer bilateral clearing to prevent strategic default by borrowers and to econo-mize on costly collateral. Central clearing is analyzed under different institutional features observed in financial markets, which place different restrictions on the contract space in the mechanism design problem. The interaction between the costly information acquisition and the limited commitment friction differs significantly in each clearing arrangement and in each set of restrictions. This results in novel lessons about the desirability of central versus bilateral clearing depending on traders' characteristics and the institutional features depening the operation of the CCP.

Baer, Herbert L. et al. Opportunity Cost and Prudentiality: An Analysis of Collateral Decisions in Bilateral and Multilateral Settings. eng. *Research in finance. Vol. 21*. Ed. by Andrew H. Chen. Bingley, U.K: Emerald, 2005. ISBN: 9781849503136.

This paper develops a model that explains how the creation of a futures clearinghouse allows traders to reduce default and economize on margin. We contrast the collateral necessary between bilateral partners with that required when multilateral netting occurs. Optimal margin levels balance the deadweight costs of default against the opportunity costs of holding additional margin. Once creasted, it may be optimal for the clearinghouse to monitor the financial condition of its members. If undertaken, monitoring will reduce the amount of margin required but need not affect the probability of default. Once created, it becomes optimal for the clearinghouse membership to expel defaulting members. This reduces the probability of default. Our empirical tests suggest that the opportunity cost of margin plays an important role in clearinghouse behavior particularly their determination of margin amounts. The relationship between volatility and margins suggests that participants face an upward-sloping opportunity cost of margin. This appears to dominate the effects that monitoring and expulsion might have on margin setting.

Benos, Evangelos, Gerardo Ferrara, and Angelo Ranaldo. Collateral Cycles. Bank of England Staff Working Paper (Apr. 2023).

Using supervisory data from UK central counterparties (CCPs), our paper uncovers persistent collateral cycles in which cash goes back and forth from financial markets to CCPs. In the onward phase of the cycles, clearing members utilise repurchase agreements (repos) to provide cash to CCPs so as to meet their margin requirements. This pattern is procyclical, intensifying with market volatility and driving up repo rates. In the backward phase, CCPs comply with regulations by safely investing their cash holdings primarily in reverse repos, followed by safe bonds and, to a lesser extent, central bank deposits. The return of cash by CCPs, back to financial markets via reverse repos and bond purchases, exerts downward pressure on repo rates. Overall, our findings demonstrate that CCPs have become important non-bank entities, impacting funding markets, with significant implications for financial stability and policymaking.

Benos, Evangelos, Wenqian Huang, et al. The Cost of Clearing Fragmentation. Management Science 70.6 (June 2024), pp. 3581–3596. ISSN: 1526-5501. DOI: 10.1287/mnsc.2023.4867.

Fragmenting clearing across multiple central counterparties (CCPs) is costly because global dealers cannot net positions across CCPs. They have to collateralize both the short position in one CCP and an offsetting long position in another CCP. This, coupled with a structural net order imbalance across CCPs, can cause prices to persistently differ across them ("the CCP basis"). Tests based on unique CCP data for interest-rate derivatives (IRDs) yield broad empirical support for this intuition and suggest that the clearing friction costs sellers clearing in LCH, the largest European CCP for IRDs, $80 million daily.

Bernanke, Ben S. Clearing and Settlement during the Crash. The Review of Financial Studies 3.1 (1990), pp. 133–151. ISSN: 08939454, 14657368. http://www.jstor.org/stable/2961962 (visited on 07/13/2025).

This article is a reexamination of the clearing and settlement process in financial markets (particularly the futures market) and its performance during the 1987 stock market crash. It provides both some institutional background and some conceptual perspective on the problems faced by the system during the week of October 19. Much of the discussion is based on the useful analogies that can be drawn between the clearinghouse and other financial intermediaries, such as banks and insurance companies. A major conclusion is that the Federal Reserve played a vital role in protecting the integrity of the clearing and settlements system during the crash.

Biais, Bruno, Florian Heider, and Marie Hoerova. CLEARING, COUNTERPARTY RISK AND AGGREGATE RISK. ECB Working Paper Series (Oct. 2012).

We study the optimal design of clearing systems. We analyze how counterpartyrisk should be allocated, whether traders should be fully insured against that risk,and how moral hazard a¤ects the optimal allocation of risk. The main advantage ofcentralized clearing, as opposed to no or decentralized clearing, is the mutualization ofrisk. While mutualization fully insures idiosyncratic risk, it cannot provide insuranceagainst aggregate risk. When the latter is significant, it is efficient that protection buy-ers exert effort to find robust counterparties, whose low default risk makes it possiblefor the clearing system to withstand aggregate shocks. When this effort is unobserv-able, incentive compatibility requires that protection buyers retain some exposure tocounterparty risk even with centralized clearing.

Bignon, Vincent and Guillaume Vuillemey. The Failure of a Clearinghouse: Empirical Evidence*. Review of Finance 24.1 (Dec. 2018), pp. 99–128. ISSN: 1572-3097. DOI: 10.1093/rof/rfy039. eprint: https://academic.oup.com/rof/article-pdf/24/1/99/31899415/rfy039.pdf.

How can we design safe financial institutions, and how should we efficiently resolve them? We study these questions by empirically analyzing the failure of a derivatives central clearing counterparty (CCP) in Paris in 1974. First, we identify the risk management failures that caused the default and draw implications for CCP design. Second, we show evidence of new agency problems arising when supervisors have discretionary powers over debt restructuring for a failed entity. These conflicts, between managers and the supervisor (misreporting), as well as between managers and creditors (risk-shifting), are difficult to mitigate with regulation or covenants. Their existence has implications for the design of recovery and resolution rules for financial institutions.

Bliss, Robert R. and George G. Kaufman. Derivatives and systemic risk: Netting, collateral, and closeout.

en. Journal of Financial Stability. Rome Conference on "Derivatives and Financial Stability" 2.1 (Apr. 2006), pp. 55–70. ISSN: 1572-3089. DOI: 10.1016/j.jfs.2005.05.001. https://www.sciencedirect.com/science/article/pii/S1572308906000040 (visited on 01/04/2023).

In the U.S., as in most countries with well-developed securities markets, derivative securities enjoy special protections under insolvency resolution laws. Most creditors are "stayed" from enforcing their rights while a firm is in bankruptcy. However, many derivatives contracts are exempt from these stays. Furthermore, derivatives enjoy netting and closeout, or termination, privileges which are not always available to most other creditors. The primary argument used to motivate passage of legislation granting these extraordinary protections is that derivatives markets are a major source of systemic risk in financial markets and that netting and closeout reduce this risk. To date, these assertions have not been subjected to rigorous economic scrutiny. This paper critically re-examines this hypothesis. These relationships are more complex than often perceived. We conclude that it is not clear whether netting, collateral, and/or closeout lead to reduced systemic risk, once the impact of these protections on the size and structure of the derivatives market has been taken into account.

Boissel, Charles et al. Systemic risk in clearing houses: Evidence from the European repo market. Journal of Financial Economics 125.3 (Sept. 2017), pp. 511–536. ISSN: 0304-405X. DOI: 10.1016/j.jfineco.2017.06.010.

We study how crises affect Central Clearing Counterparties (CCPs). We focus on a large and safe segment of the CCP-cleared repo market during the Eurozone sovereign debt crisis. We develop a simple model to infer CCP stress, which is measured as repo rates' sensitivity to sovereign credit default swaps (CDS) spreads and jointly captures (1) the effectiveness of haircut policies, (2) CCP-member default risk (conditional on sovereign default), and (3) CCP default risk (conditional on both sovereign and CCP-member default). During 2011, repo rates strongly respond to sovereign risk, particularly for Greece, Italy, Ireland, Portugal and Spain (GIIPS): Repo investors behaved as if the conditional probability of CCP default was substantial.

Bolton, Patrick and Martin Oehmke. Should Derivatives be Senior? Journal of Financial Stability (June 17, 2011).

Derivative contracts, swaps, and repos enjoy "super-senior" status in bankruptcy in that they are exempt from the automatic stay on debt and collateral collection that applies to virtually all other claims. We propose a simple limited commitment corporate finance model to assess the e¤ect of this exemption on firms' cost of borrowing and incentives to engage in swaps and derivatives transactions. Our model shows that while derivatives are value-enhancing risk management tools, super-seniority for derivatives is generally inefficient: collateralization and e¤ective seniority of derivatives shifts credit risk to the firm's creditors, even though it is more efficient if this risk is borne by derivative counterparties. In addition, because super-senior derivatives dilute existing creditors, they may lead firms to take on derivative positions that are too large from a social perspective. Hence, derivatives markets may be inefficiently large in equilibrium.

Boudiaf, Ismael Alexander, Martin Scheicher, and Francesco Vacirca. CCP Initial Margin Models in Europe. SSRN Electronic Journal (2023). ISSN: 1556-5068. DOI: 10.2139/ssrn.4411243.

In this paper we aim to provide a holistic understanding of the Initial Margin (IM) models used by Central Counterparties (CCPs) in Europe. In addition to discussing their relevance in terms of CCP risk management and their importance for the functioning of financial markets, we provide

an overview of the main modelling frameworks used, including Standard Portfolio Analysis of Risk (SPAN) and Value at Risk (VaR) models.By leveraging on publicly available data, we provide an up-to-date picture of current modelling practices for specific cleared product classes, as well as various trends in IM modelling practices in Europe. We show how IM model frameworks vary materially, depending on the CCP's past choices and the products it clears. Despite a propensity to switch to VaR models, idiosyncrasies and differences across CCPs are likely to persist.We conclude by highlighting current and upcoming challenges and risks to CCP IM model frameworks and linking the current status quo with ongoing and upcoming regulatory work at European and international level.

Braithwaite, Jo. The Dilemma of Client Clearing in the OTC Derivatives Markets. European Business Organization Law Review 17.3 (Sept. 2016), pp. 355–378. ISSN: 1741-6205. DOI: 10.1007/s40804-016-0044-0.

The global crisis triggered a vast programme of financial markets reform, including a new regime for over-the-counter (OTC) derivatives which requires hitherto private contracts to be cleared through central counterparties (CCPs). This article argues that the interaction between underlying law and this new regulation needs to be addressed in order to advance the objectives of the reforms. The starting point for the argument is the two techniques that underpin CCPs: limited access and posting assets, or margin. Having established that access via intermediated or 'client' clearing will become increasingly important with mandatory clearing, the article explores the impact of client clearing on the legal rules governing the margin posted by users of a CCP. The detail of the interaction between European regulations on CCP clearing and the UK rules on client assets is considered as an example. The dilemma identified arises because regulation, designed to improve financial stability by mandating clearing, may potentially undermine certain ways in which CCPs promote that outcome. The article concludes that the interaction between underlying law and new regulation needs to be accounted for and addressed at EU level, in order to safeguard the functions that attracted regulators to clearing in the first place.

Braithwaite, Jo and David Murphy. Get the balance right: private rights and public policy in the post-crisis regime for OTC derivatives. Capital Markets Law Journal 12.4 (Sept. 2017), pp. 480–509. ISSN: 1750-7227. DOI: 10.1093/cmlj/kmx033.

The reforms introduced since the 2008 financial crisis have left OTC derivatives in a state of hybridity. What was once a largely private, bilateral market, relatively unconstrained by public policy, has been transformed by a variety of regulatory initiatives. The principal ones for our purposes are the mandatory central clearing of certain standardized OTC derivatives; higher capital requirements for bilateral OTC portfolios; and the requirement for many parties to post initial margin and exchange variation margin with their counterparties on their OTC derivatives exposures. These reforms have built upon features of the pre-crisis OTC derivatives market, preserving some aspects and modifying others. The result is a legal and regulatory framework which is an amalgam of private and public law elements. The goal of this article is to explore the implications of this hybridity in the context of ongoing debates about the recovery and resolution of central counterparties (CCPs).

Braithwaite, Joanne P. Private Law and the Public Sector's Central Counterparty Prescription for the Derivatives Markets. SSRN Electronic Journal (2011). ISSN: 1556-5068. DOI: 10.2139/ssrn.1791740.

In the wake of the financial crisis considerable momentum has built-up behind proposals to extend central counterparty (CCP) clearing in the over-the-counter derivatives markets. However, the implementation of new rules is proving complex. This paper argues that one cause of this complexity is that the public sector is seeking to incorporate into legislation (and require the wider use of) a privately owned and operated risk management mechanism. As a matter of law, the paper argues that CCP clearing can be understood as a market-generated 'legal device'; in other words, one designed to support the markets by means of the interaction of various private law techniques. Following this analysis through, the paper highlights the benefits and drawbacks which derive from the legal techniques underlying CCP clearing (standardisation of contracts, asset-backing, netting, and so on) and argues that these qualities are inherent to the device. It concludes that the inherent capacity of CCP clearing gives rise to a qualitatively different set of challenges for policymakers than those arising from technical implementation, and it explains that both types of problem need to be addressed if the CCP prescription is to be effective.

Braithwaite, Joanne P. Law after Lehmans. SSRN Electronic Journal (2014). ISSN: 1556-5068. DOI: 10.2139/ssrn.2391148.

The September 2008 collapse of the Lehman Brothers group marked the nadir of the global financial crisis. While the regulatory aftermath has been extensively debated, the effects of the case law that arose from the insolvency have not. This paper explains the need to redress the balance. It starts by considering the quantity and qualities of the Lehmans case law, examining why the 30 plus decisions handed down by the English courts enjoy an unusually high precedent-setting potential. The paper proceeds by analysing the precedential effects of these decisions, and it reports on a recent workshop held at the London School of Economics that met to consider this question. Subject to the event's terms of engagement, the paper draws out several themes from the discussion, including the impact of the Lehmans cases on the principles of contractual interpretation, the law of trusts and insolvency law. By way of conclusion, it is submitted that the impact of Lehmans case law reaches far beyond that particular insolvency, to worldwide users of standard form documents, the global financial markets and the common law itself. Seen in this light, the Lehmans case law is a significant, but under-appreciated, side-effect of the global financial crisis.

Cabedo, Yaiza. Report to the European Commission Report on post trade risk reduction services with regards to the clearing obligation (EMIR Article 85(3a). Nov. 10, 2020.

Campbell, Sean D. and Ivan Ivanov. Empirically Evaluating Systemic Risks in CCPs: The Case of Two CDS CCPs. SSRN Electronic Journal (2016). ISSN: 1556-5068. DOI: 10.2139/ssrn.2841076.

We empirically evaluate the systemic stability of two large CDS CCPs. We show that positive correlations between the exposures of large dealers could lead to substantially larger combined stress losses to a CCP than if we consider dealers in isolation. These results highlight crowded trade concerns. We then study the risk faced by a set of CCPs from the clearing activities of their common dealers. We that the high positive correlations in exposures of dealers across CCPs can lead to dealers experiencing large losses to both CCP simultaneously. Our study illustrates the potential for contagion of stress through CCPs.

Capponi, Agostino et al. The collateral rule: Evidence from the credit default swap market. Journal of Monetary Economics 126 (2022), pp. 58–86. ISSN: 0304-3932. DOI: 10.1016/j.jmoneco.2021.12.003. https://www.sciencedirect.com/science/article/pii/S0304393221001458.

In this paper, we explore a novel dataset of daily credit default swap (CDS) positions cleared by the largest CDS clearinghouse along with posted margins to study how collateral varies with portfolio risks and market conditions. Contrary to many theoretical models, where collateral constraints follow Value-at-Risk rules, we find strong evidence that collateral requirements are set an order of magnitude larger than what Value-at-Risk rules imply. The panel variation in collateralization rates is well captured by measures of extreme tail risks. We develop a model of endogenous collateral, which explains the conservativeness of collateral levels through disagreement about extreme states.

Cerezetti, Fernando, Jorge Cruz Lopez, et al. Who pays? Who gains? Central counterparty resource provision in the post-Pittsburgh world. Journal of Financial Market Infrastructures (2019). ISSN: 2049-5404. DOI: 10.21314/jfmi.2018.108.

At the Pittsburgh Summit in 2009, G20 leaders agreed to wide-reaching reforms to over-the-counter (OTC) derivatives markets. One of these reforms required the clearing of standardized OTC derivatives through central counterparties (CCPs). Since then, CCPs have become increasingly important. There has been an extensive programme of regulatory change affecting CCPs, OTC derivatives markets and their participants. As OTC clearing has grown, tension has increased between different classes of market participants over the traditional CCP model of resource provision through loss mutualization. We argue that most of this tension can be explained by a misalignment between the policy goal of enhancing financial stability and the delivery of that goal by mandating clearing through CCPs as they are currently organized. Specifically, the traditional model for resource provision makes most CCPs suitable for managing "club goods", whereas financial stability is a "public good". The key differences between these two types of goods, driven by the wedge between those who pay for them and those who derive the benefits, create the observed tensions. Based on this analysis, we propose a framework to analyze the functional elements of a CCP and examine whether an alternative clearing model might be more effective. We conclude that incentives would be better aligned if the functions of CCPs were unbundled and the ownership and funding structures that best suit their individual characteristics were selected. Functions that are critical for the provision of financial stability might suggest some form of public sector involvement, whereas other services might lend themselves to a for-profit or traditional club model.

Cerezetti, Fernando, Anannit Sumawong, et al. Market liquidity, closeout procedures and initial margin for CCPs. Bank of England Staff Working Paper (2007).

Closeout procedures enable central counterparties (CCPs) to respond to events that challenge the continuity of their normal operations, most frequently triggered by the default of one or more clearing members. The procedures ensure the regularity of the settlement process through the prudent and orderly closeout of the defaulter's portfolio. Traditional approaches to CCPs' margin requirements typically assume a simple closeout profile, and do not account for the 'real-life' constraints embedded on the management of a default. The paper proposes an approach of evaluating how distinct closeout strategies may expose a CCP to different sets of risk and costs, and consequently could impact the sufficiency of financial resources to cover its risk exposure to a default. The approach is based on a counterfactual simulation, and evaluates a full spectrum of hedging strategies in an exploratory and model-free manner, deriving endogenous and market-dependent risk metrics. Using the trade repository data available to the Bank (as a result of EMIR reporting) on over-the-counter (OTC) interest rate swaps (IRS) and ten years (ie 2005 to 2015) of information on related market risk

factors, the paper derives empirically an efficient hedging strategy that minimizes the CCP's risk exposure to a defaulting clearing member. Endogenous trade-off structures between total risk (market risk plus funding needs) and transaction costs are also established, with marginal sensitivities to individual components of the hedging strategy determined.

Chang, Felix B. The Systemic Risk Paradox. en. Columbia Business Law Review (2015), Vol. 2014 No. 3. DOI: 10.7916/CBLR.V2014I3.1783.

Consolidation in the financial industry threatens competition and increases systemic risk. Recently, banks have seen both high-profile mergers and spectacular failures, prompting a flurry of regulatory responses. Yet consolidation has not been as closely scrutinized for clearinghouses, which facilitate trading in securities and derivatives products. These nonbank intermediaries can be thought of as middlemen who collect deposits to ensure that each buyer and seller has the wherewithal to uphold its end of the deal. Clearinghouses mitigate the credit risks that buyers and sellers would face if they dealt directly with each other. Yet here lies the dilemma: large clearinghouses reduce credit risk, but they heighten systemic risk since the collapse of one such entity threatens the entire financial system. While regulators have tackled the systemic risks posed by large banks, the systemic risks of these nonbank intermediaries have received less attention. In fact, financial reform has spurred clearinghouse growth and consolidation. This Article examines the paradoxical treatment of regulators toward the systemic risks of clearinghouses and banks. It explores two fundamental questions: Why does the paradox exist, and who benefits from it? This Article borrows from antitrust to offer a framework for ensuring that the entities that control a large clearinghouse (large, heavily regulated banks) do not abuse that clearinghouse's market dominance.

Cont, Rama and Samim Ghamami. Skin in the Game: Risk Analysis of Central Counterparties. SSRN Electronic Journal (Sept. 27, 2023). ISSN: 1556-5068. DOI: 10.2139/ssrn.4584822.

This paper introduces an incentive compatibility framework to analyze agency problems linked to central counterparty (CCP) risk management. Our framework, which is based on a modern approach to extreme value theory, is used to design CCP skin-in-the-game (SITG). We show that under inadequate SITG levels, members are more exposed to default losses than CCPs. The resulting risk management incentive distortions could be mitigated by using the proposed SITG formulations. Our analysis addresses investor-owned and member-owned CCPs, we also analyze multilayered and monolayer default waterfalls. Viewing the total size of SITG as the lower bound on CCP regulatory capital, the framework can be used to improve capital regulation of investor-owned and member-owned CCPs. We also demonstrate that bank capital rules for CCP exposures may underestimate risk. The broader central clearing mandate of U.S. Treasuries may take place under monolayer CCPs. These clearinghouses may need to allocate more of their own capital to the default waterfall.

Cont, Rama and Thomas Kokholm. Central Clearing of OTC Derivatives: Bilateral vs Multilateral Netting. en. SSRN 2140055 (Sept. 2012). DOI: 10.2139/ssrn.2140055. https://papers.ssrn.com/abstract=2140055 (visited on 03/27/2023).

We study the impact of central clearing of over-the-counter (OTC) transactions on counterparty exposures in a market with OTC transactions across several asset classes with heterogeneous characteristics. We find that the impact, on total expected interdealer exposure, of introducing a central counterparty (CCP) for a single class of OTC derivatives is sensitive to assumptions on heterogeneity of asset classes in terms of 'riskyness' of the asset class as well as correlation of exposures across

asset classes. In particular, while an analysis assuming independent, homogeneous exposures suggests that central clearing is efficient only if one has an unrealistically high number of participants, the opposite conclusion is reached if differences in riskyness and correlation across asset classes are realistically taken into account. Empirically plausible specifications of these parameters lead to the conclusion that the gain from multilateral netting in a CCP overweighs the loss of netting across asset classes in bilateral netting agreements. When a CCP exists for interest rate derivatives, adding a CCP for credit derivatives is shown to decrease overall exposures. These findings are shown to be robust to the choice of distribution for OTC derivatives exposures.

Cont, Rama, Amal Moussa, and Edson B. Santos. Network Structure and Systemic Risk in Banking Systems. *Handbook on Systemic Risk*. Ed. by Jean-Pierre Fouque and Joseph A. Langsam. Cambridge: Cambridge University Press, May 2013, pp. 327–368. ISBN: 9781107023437. DOI: 10.1017/CBO9781139151184.018. https://www.cambridge.org/core/books/handbook-on-systemic-risk/network-structure-and-systemic-risk-in-banking-systems/9BB92BC1B1373738AE32258E09A649B0 (visited on 02/02/2023).

We present a quantitative methodology for analyzing the potential for contagion and systemic risk in a network of interlinked financial institutions, using a metric for the systemic importance of institutions: the Contagion Index.We apply this methodology to a data set of mutual exposures and capital levels of financial institutions in Brazil in 2007 and 2008, and analyze the role of balance sheet size and network structure in each institution's contribution to systemic risk. Our results emphasize the contribution of heterogeneity in network structure and concentration of counterparty exposures to a given institution in explaining its systemic importance. These observations plead for capital requirements which depend on exposures, rather than aggregate balance sheet size, and which target systemically important institutions.Keywords Default risk, domino effects, balance sheet contagion, scale-free network, default contagion, systemic risk, macro-prudential regulation, random graph.IntroductionThe recent financial crisis has emphasized the importance of systemic risk, defined as macro-level risk which can impair the stability of the entire financial system. Bank failures have led in recent years to a disruption of the financial system and a significant spillover of financial distress to the larger economy (Hellwig, 2009). Regulators have had great difficulties anticipating the impact of defaults partly due to a lack of visibility on the structure of the financial system as well as a lack of a methodology for monitoring systemic risk. The complexity of the contemporary financial systems makes it a challenge to define adequate indicators of systemic risk that could help in an objective assessment of the systemic importance of financial institutions and an objective framework for assessing the efficiency of macro-prudential policies.

Cox, Robert T. and Robert S. Steigerwald. "Incomplete demutualization" and financial market infrastructure: central counterparty ownership and governance after the crisis of 2008–9. The Journal of Financial Market Infrastructures 4.3 (Mar. 2016), pp. 25–38. ISSN: 2049-5404. DOI: 10.21314/jfmi.2016.057.

In this paper, we examine a key conflict between the owners and clearing members of "demutualized" central counterparties (CCPs), in which ownership is separated from clearing participation. Despite the advent of demutualization in the early 1990s, clearing members remain the ultimate underwriters of CCP default risk, a situation we describe as "incomplete demutualization". Fundamental changes in regulatory and financial stability policy in thewake of the crisis of 2008-9 have led clearing

members to reassess their role in CCP default management. This, in turn, has led to skirmishes between some CCPs and clearing members over a variety of risk-related issues. Policy responses to this conflict should focus primarily on the incentives of both CCPs and clearing members to participate collaboratively in CCP default management, and on the overall resilience of central clearing arrangements. Continued conflict over governance may make it impossible for a CCP in crisis to recover and may also hinder resolution efforts.

CPMI-IOSCO. *Public quantitative disclosure standards for central counterparties*. Tech. rep. Feb. 2015. https://www.bis.org/cpmi/publ/d125.pdf.

CPSS-IOSCO. *Principles for financial market infrastructures*. Tech. rep. Apr. 2012. https://www.bis.org/cpmi/publ/d101a.pdf.

D'Erasmo, Pablo, Selman Erol, and Guillermo Ordoñez. Regulating Clearing in Networks. SSRN Electronic Journal (Nov. 20, 2022). ISSN: 1556-5068. DOI: 10.2139/ssrn.4927929.

Recent regulations in the U.S. and Europe incentivize the use of central counterparty clearing houses (CCP) to clear derivatives, arguably to create a less complex and more transparent interbank network that is less prone to financial instabilities. We construct a network model with endogenous exposures and show that the core and the periphery react asymmetrically to these regulations. The core values opacity more and adopts clearing less. Consequently, bilaterally netted exposures to the core increase. The regulation also makes the CCP more exposed to the core than the periphery was pre-regulation. This endogenous network reaction to the regulation creates the unanticipated effect of reducing financial stability through more frequent coordination failures that start at the core and spread to the periphery and the CCP. A novel dataset on U.S. counterparty exposures, before and after the regulations, confirm the model's testable implications.

D'Errico, Marco and Tarik Roukny. Compressing Over-the-Counter Markets. Operations Research 69.6 (Nov. 2021), pp. 1660–1679. ISSN: 0030-364X. DOI: 10.1287/opre.2021.2107. (Visited on 02/07/2023).

Over-the-counter markets are at the center of the global reform of the financial system. We show how the size and structure of these markets can undergo rapid and extensive changes when participants engage in portfolio compression, which is an optimization technology that exploits multilateral netting opportunities. We find that tightly knit and concentrated trading structures, as featured by many large over-the-counter markets, are especially susceptible to reductions of notional amounts and network reconfigurations resulting from compression activities. Using a unique transaction-level data set on credit-default-swaps markets, we estimate reduction levels, suggesting that the adoption of this technology can account for a large share of the historical development observed in these markets since the global financial crisis. Finally, we test the effect of a mandate to centrally clear over the counter markets in terms of size and structure. When participants engage in both central clearing and portfolio compression with the clearinghouse, we find large netting failures if clearinghouses proliferate. Allowing for compression across clearinghouses by and large offsets this adverse effect.

Dolatabadi, Sepideh, Morten Orregaard Nielsen, and Ke Xu. A Fractionally Cointegrated VAR Analysis of Price Discovery in Commodity Futures Markets. Journal of Futures Markets 35.4 (Oct. 27, 2014), pp. 339–356. DOI: 10.1002/fut.21693.

In this paper, we apply the recently developed fractionally cointegrated vector autoregressive (FCVAR) model to analyze price discovery in the spot and futures markets for five non-ferrous metals

(aluminum, copper, lead, nickel, and zinc). The FCVAR model allows for long memory (fractional integration) in the equilibrium errors, and, following Figuerola-Ferretti and Gonzalo (2010), we allow for the existence of long-run backwardation or contango in the equilibrium as well, that is, a non-unit cointegration coefficient. Price discovery can be analyzed in the FCVAR model by a relatively straightforward examination of the adjustment coefficients. In our empirical analysis, we use the data from Figuerola-Ferretti and Gonzalo (2010), who conduct a similar analysis using the usual (non-fractional) CVAR model. Our first finding is that, for all markets except copper, the fractional integration parameter is highly significant, showing that the usual, non-fractional model is not appropriate. Next, when allowing for fractional integration in the long-run equilibrium relations, fewer lags are needed in the autoregressive formulation, further stressing the usefulness of the fractional model. Compared to the results from the non-fractional model, we find slightly more evidence of price discovery in the spot market. Specifically, using standard likelihood ratio tests, we do not reject the hypothesis that price discovery takes place exclusively in the spot (futures) market for copper, lead, and zinc (aluminum and nickel).

Du, Shengwu and Travis D. Nesmith. Portfolio Margining Using PCA Latent Factors. Finance and Economics Discussion Series 2025–016 (Feb. 2025), pp. 1–1. ISSN: 2767-3898. DOI: 10.17016/feds.2025.016.

Filtered historical simulation (FHS)—a simple method of calculating Value-at-Risk that reacts quickly to changes in market volatility—is a popular method for calculating margin at central counterparties. However, FHS does not address how correlation can vary through time. Typically, in margin systems, each risk factor is filtered individually so that the computational burden increases linearly as the number of risk factors grows. We propose an alternative method that filters historical returns using latent risk factors derived from principal component analysis. We compare this method's performance with "traditional" FHS for different simulated and constructed portfolios. The proposed method performs much better when there are large changes in correlation. It also performs well when that is not the case, although some care needs to be taken with certain concentrated portfolios. At the same time, the computational requirements can be reduced significantly. Backtesting comparisons are performed using data from 2020 when markets were stressed by the COVID-19 crisis.

Duffie, Darrell. Resolution of Failing Central Counterparties. en. *Making Failure Feasible*. 2558226. Rochester, NY, Dec. 2015. (Visited on 12/19/2022).

A central counterparty (CCP) is a financial market utility that lowers counterparty default risk on specified financial contracts by acting as a buyer to every seller, and as a seller to every buyer. When at risk of failure, a CCP could be forced into a normal insolvency process such as bankruptcy, or an administrative failure resolution process. This chapter reviews some alternative approaches to the design of insolvency and failure resolution regimes for CCPs. I focus on the allocation of losses and the question of whether and how to provide for continuity of clearing services. I discuss how one might adapt to CCPs some of the failure resolution approaches currently being designed for other forms of systemically important financial institutions. A key policy question is when to interrupt a contractually based CCP default management process with an overriding failure resolution process.

— Compression Auctions With an Application to LIBOR-SOFR Swap Conversion PRELIMINARY. Stanford GSB Research Papers (Sept. 10, 2018).

This note explains a new type of auction based on an existing derivatives risk-management technique known as "compression." A compression auction can be used to convert centrally cleared contracts on an underlying benchmark, such as the London Interbank Offered Rate (LIBOR), to contracts on a different underlying benchmark, such as the Secured Overnight Financing Rate (SOFR).

Duffie, Darrell, Martin Scheicher, and Guillaume Vuillemey. Central clearing and collateral demand. en. Journal of Financial Economics 116.2 (May 2015), pp. 237–256. ISSN: 0304-405X. DOI: 10.1016/j.jfineco.2014.12.006. https://www.sciencedirect.com/science/article/pii/S0304405X14002761 (visited on 03/29/2023).

We use an extensive data set of bilateral credit default swap (CDS) positions to estimate the impact on collateral demand of new clearing and margin regulations. The estimated collateral demands include initial margin and the frictional demands associated with the movement of variation margin through the network of market participants. We estimate the impact on total collateral demand of more widespread initial margin requirements, increased novation of CDS to central clearing parties (CCPs), an increase in the number of clearing members, the proliferation of CCPs of both specialized and non-specialized types, collateral rehypothecation practices, and client clearing. System-wide collateral demand is increased significantly by the application of initial margin requirements for dealers, whether or not the CDS are cleared. Given these dealer-to-dealer initial margin requirements, mandatory central clearing is shown to lower, not raise, system-wide collateral demand, provided there is no significant proliferation of CCPs. Central clearing does, however, have significant distributional consequences for collateral requirements across market participants.

Duffie, Darrell and Haoxiang Zhu. Does a Central Clearing Counterparty Reduce Counterparty Risk? The Review of Asset Pricing Studies 1.1 (July 2011), pp. 74–95. ISSN: 2045-9920. DOI: 10.1093/rapstu/rar001. eprint: https://academic.oup.com/raps/article-pdf/1/1/74/24404255/rar001.pdf.

We show whether central clearing of a particular class of derivatives lowers counterparty risk. For plausible cases, adding a central clearing counterparty (CCP) for a class of derivatives such as credit default swaps reduces netting efficiency, leading to an increase in average exposure to counterparty default. Further, clearing different classes of derivatives in separate CCPs always increases counterparty exposures relative to clearing the combined set of derivatives in a single CCP. We provide theory as well as illustrative numerical examples of these results that are calibrated to notional derivatives position data for major banks.

Eisenberg, Larry and Thomas H. Noe. Systemic Risk in Financial Systems. Management Science 47.2 (Feb. 2001), pp. 236–249. ISSN: 1526-5501. DOI: 10.1287/mnsc.47.2.236.9835.

We consider default by firms that are part of a single clearing mechanism. The obligations of all firms within the system are determined simultaneously in a fashion consistent with the priority of debt claims and the limited liability of equity. We first show, via a fixed-point argument, that there always exists a "clearing payment vector" that clears the obligations of the members of the clearing system; under mild regularity conditions, this clearing vector is unique. Next, we develop an algorithm that both clears the financial system in a computationally efficient fashion and provides information on the systemic risk faced by the individual system firms. Finally, we produce qualitative comparative statics for financial systems. These comparative statics imply that, in contrast to single-firm results,

even unsystematic, nondissipative shocks to the system will lower the total value of the system and may lower the value of the equity of some of the individual system firms.

Faruqui, Umar, Wenqian Huang, and Elod Takáts. Clearing Risks in OTC Derivatives Markets: The CCP-Bank Nexus. en. BIS Quarterly Review 3316367 (Dec. 2018). https://papers.ssrn.com/abstract=3316367 (visited on 03/29/2023).

Systemically important banks and central counterparties (CCPs) interact in highly concentrated over-the-counter (OTC) derivatives markets. We outline the CCP-bank nexus to think about the endogenous interactions between banks and CCPs in periods of stress. As these interactions could potentially lead to destabilising feedback loops, the risks of banks and CCPs should be considered jointly, rather than in isolation.

Ferrara, Gerardo, Xin Li, and David Marszalec. Central counterparty auction design. Bank of England Staff Working Paper (Aug. 2017).

We analyze the role of auctions in managing the default of a clearing member in a generic central counterparty (CCP). We first consider three established alternative sealed bid auction formats in which clearing members simultaneously submit bids for a defaulting clearing member's portfolio: first price without penalty, first price with penalty, and first price with budget constraints. Under our assumptions regarding bidders' behaviour, although the revenue of the portfolio by the CCP might be the same for these auction formats mentioned above, there could be significant differences in the externalities arising from each of them. Additionally, this paper considers how mechanisms to incentivize competitive bidding could, in some circumstances, have adverse implications for financial stability by inefficiently distributing losses to surviving clearing members. In response to these potential adverse implications, we propose a fourth auction type-second price with loss sharing-which takes into account a bidder's consideration that may bear part of the CCP's losses.

Fleming, Michael and Asani Sarkar. The Failure Resolution of Lehman Brothers. FRBNY Economic Policy Review (Dec. 2014).

We examine the resolution of Lehman Brothers Holdings Inc. in the U.S.Bankruptcy Court in order to understand the sources of complexity in itsresolution and inform the debate on appropriate resolution mechanisms forfinancial institutions. We focus on the settlement of Lehman's creditor andcounterparty claims, especially those relating to over-the-counter derivatives,where much of the complexity of Lehman's bankruptcy resolution wasrooted. We find that creditors' recovery rate was 28 percent, below historicalaverages for firms comparable to Lehman. Losses were exacerbated by poorbankruptcy planning and mitigated by timely funding from the Fed. Thesettlement of OTC derivatives was a long and complex process, occurring ondifferent tracks for different groups of derivatives creditors. Consequently, theresolution process was less predictable than expected, and it was difficult toobtain an informed view of the process.

France, Virginia G. and Charles M. Kahn. Law as a constraint on bailouts: Emergency support for central counterparties. Journal of Financial Intermediation 28 (Oct. 2016), pp. 22–31. ISSN: 1042-9573. DOI: 10.1016/j.jfi.2016.08.005.

Increased awareness of the importance of non-bank financial infrastructures has brought increased concern about the potential for bailouts and the resultant moral hazard problem. This paper examines the question with regard to derivatives central counterparties. We consider the layers of protection that derivatives central clearing parties (CCPs) have established in the absence of an

expectation of regulatory rescue. We then provide a model of the tension between the desire for ex post rescue of a systemically important financial infrastructure and the desire to maintain ex ante discipline on the infrastructure. The model illustrates the factors that should lead to relaxation or tightening of the financial regulator's discretion for rescue. We consider examples of failures of derivatives CCPs in order to highlight the importance of these considerations.

Ghamami, Samim and Paul Glasserman. Does OTC derivatives reform incentivize central clearing? Journal of Financial Intermediation 32 (Oct. 2017), pp. 76–87. ISSN: 1042-9573. DOI: 10.1016/j.jfi.2017.05.007.

Regulatory changes in the over-the-counter (OTC) derivatives market seek to reduce systemic risk. The reforms require that standardized derivatives be cleared through central counterparties (CCPs), and they set higher capital and margin requirements for non-centrally cleared derivatives. We investigate whether these requirements create a cost incentive in favor of central clearing, as intended. We compare the total capital and collateral costs when banks transact fully bilaterally and when they clear all contracts through CCPs. We calibrate our model using data on the OTC market collected by the Federal Reserve. We find that the cost incentive may not favor central clearing. The main factors driving the cost comparison are netting benefits, the margin period of risk, and CCP guarantee fund requirements. Lower guarantee fund requirements lower the cost of clearing but make CCPs less resilient.

Ghamami, Samim, Paul Glasserman, and H. Peyton Young. Collateralized Networks. Management Science 68.3 (Mar. 2022), pp. 2202–2225. ISSN: 1526-5501. DOI: 10.1287/mnsc.2020.3938.

This paper studies the spread of losses and defaults in financial networks with two interrelated features: collateral requirements and alternative contract termination rules. When collateral is committed to a firm's counterparties, a solvent firm may default if it lacks sufficient liquid assets to meet its payment obligations. Collateral requirements can, thus, increase defaults and payment shortfalls. Moreover, one firm may benefit from the failure of another if the failure frees collateral committed by the surviving firm, giving it additional resources to make other payments. Contract termination at default may also improve the ability of other firms to meet their obligations through access to collateral. As a consequence of these features, the timing of payments and collateral liquidation must be carefully specified to establish the existence of payments that clear the network. Using this framework, we show that dedicated collateral may lead to more defaults than pooled collateral, we study the consequences of illiquid collateral for the spread of losses through fire sales, we compare networks with and without selective contract termination, and we analyze the impact of alternative resolution and bankruptcy stay rules that limit the seizure of collateral at default. Under an upper bound on derivatives leverage, full termination reduces payment shortfalls compared with selective termination.

Glasserman, Paul, Ciamac Moallemi, and Kai Yuan. Hidden Illiquidity with Multiple Central Counterparties. OFR Working Paper Series (May 7, 2015).

Regulatory changes are transforming the multi-trillion dollar swaps market from a networkof bilateral contracts to one in which swaps are cleared through central counterparties (CCPs).The stability of the new framework depends on the resilience of CCPs. Margin requirementsare a CCP's first line of defense against the default of a counterparty. To capture liquiditycosts at default, margin requirements need to increase superlinearly in position size. However,convex margin requirements create an

incentive for a swaps dealer to split its positions acrossmultiple CCPs, effectively "hiding" potential liquidation costs from each CCP. To compensate,each CCP needs to set higher margin requirements than it would in isolation. In a model withtwo CCPs, we define an equilibrium as a pair of margin schedules through which both CCPscollect sufficient margin under a dealer's optimal allocation of trades. In the case of linear priceimpact, we show that a necessary and sufficient condition for the existence of an equilibrium isthat the two CCPs agree on liquidity costs, and we characterize all equilibria when this holds.A difference in views can lead to a race to the bottom. We provide extensions of this result anddiscuss its implications for CCP oversight and risk management.

Glasserman, Paul and H. Peyton Young. How likely is contagion in financial networks? Journal of Banking and Finance 50 (Jan. 2015), pp. 383–399. ISSN: 0378-4266. DOI: 10.1016/j.jbankfin.2014.02.006.

Interconnections among financial institutions create potential channels for contagion and amplification of shocks to the financial system. We estimate the extent to which interconnections increase expected losses and defaults under a wide range of shock distributions. In contrast to most work on financial networks, we assume only minimal information about network structure and rely instead on information about the individual institutions that are the nodes of the network. The key node-level quantities are asset size, leverage, and a financial connectivity measure given by the fraction of a financial institution's liabilities held by other financial institutions. We combine these measures to derive explicit bounds on the potential magnitude of network effects on contagion and loss amplification. Spillover effects are most significant when node sizes are heterogeneous and the originating node is highly leveraged and has high financial connectivity. Our results also highlight the importance of mechanisms that go beyond simple spillover effects to magnify shocks; these include bankruptcy costs, and mark-to-market losses resulting from credit quality deterioration or a loss of confidence. We illustrate the results with data on the European banking system.

Grothe, Magdalena, N. Aaron Pancost, and Stathis Tompaidis. Collateral competition: Evidence from central counterparties. Journal of Financial Economics 149.3 (2023), pp. 536–556. ISSN: 0304-405X. DOI: 10.1016/j.jfineco.2023.06.005. https://www.sciencedirect.com/science/article/pii/S0304405X23001198.

We analyze competition and risk management at central counterparties (CCPs) using a granular transaction-level dataset, and find that CCPs decrease collateral in response to lower collateral at their competitors, an effect that becomes stronger as the correlation between positions increases. To interpret our findings, we derive a model in which collateral is driven by risk and CCP competition. Our results are consistent with the model and suggest that a single monopolistic CCP would require more collateral. We also show that amid the substantial increase in collateral during the Covid-19 pandemic, the probability of a margin breach did not significantly change.

Guse, Matthew, Matthew Hoops, and Maria Perozek. Central Clearing Counterparties in the Financial Accounts of the United States. FEDS Notes (July 12, 2024). DOI: 10.17016/2380-7172.3540.

Halili, Alba, Jean-Pierre Fenech, and Silvio Contessi. Credit Derivatives and Bank Systemic Risk: Risk Enhancing or Reducing? Finance Research Letters 42 (Jan. 9, 2021), p. 101930. DOI: 10.1016/j.frl.2021.101930.

This study investigates the impact of credit derivative usage on U.S. bank holding companies' systemic risk from 2006 to 2018. The results show that an increase in bank holdings of credit derivatives

subsequently increases their systemic risk. This is robust to a number of controls. Such findings have policy implications for regulators and market participants, as larger banks are in a higher risk category, potentially causing further disruption to financial markets.

Heath, Alexandra, Gerard Kelly, and Mark Manning. Central Counterparty Loss Allocation and Transmission of Financial Stress. RBA Research Discussion Paper 2 (2015).

Among the reforms to over-the-counter (OTC) derivative markets since the global financial crisis is a commitment to collateralise counterparty exposures and to clear standardised contracts via central counterparties (CCPs). The reforms aim to reduce interconnectedness and improve counterparty risk management in these important markets. At the same time, however, the reforms necessarily concentrate risk in one or a few CCPs and also increase institutions' demand for high-quality assets to meet collateral requirements. This paper looks more closely at the implications of these reforms for the stability of the financial network. Following Heath, Kelly and Manning (2013), the paper examines liquidity and solvency risk under alternative clearing configurations, but extends the analysis in two main ways. First, rather than using simulated data, it uses actual data on the derivative positions of the 41 largest bank participants in global OTC derivative markets in 2012 (as previously used by the Bank for International Settlements' Macroeconomic Assessment Group on Derivatives). Second, it extends the methodology to consider in greater depth the implications of loss allocation by CCPs to meet obligations once pre-funded financial resources have been exhausted, and in particular the mechanism of variation margin gains haircutting. This mechanism is considered in international standard-setters' guidance on recovery planning for CCPs and has been adopted by some CCPs. The paper demonstrates that designing and operating CCPs in accordance with international standards can limit the potential for stress to propagate through the system, even in very extreme market conditions.

Heilbron, John. Central clearing and trade cancellation: the case of London Metal Exchange nickel contracts on March 8, 2022. The Journal of Financial Market Infrastructures (2024). ISSN: 2049-5412. DOI: 10.21314/jfmi.2024.010.

In March 2022, nickel prices on the London Metal Exchange (LME) nearly quadrupled in just three trading days, threatening to put several clearing members into default and exhaust the default fund at LME Clear, the exchange's central counterparty (CCP). The LME responded in an unprecedented fashion, by cancelling eight hours of nickel market trades. Though challenged in court, its authority to do so was ultimately upheld. This paper documents the market stress and LME's response in order to understand the implications of the trade cancellation decision for financial stability and CCP powers going forward. While LME's trade cancellation helped to alleviate distress, its decision runs counter to the function of a CCP, which is to ensure contract performance. In upholding LME's right to void contracts, the court's verdict could change how CCP rule books are applied under financial distress, potentially creating scope for moral hazard or other adverse consequences.

Heilbron, John and Efstathios Tompaidis. The Impact of CCP Liquidity and Capital Demands on Clearing Members Under Stress. Working Paper (2025).

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.

Henkel, Christoph. Using Central Counterparties to Limit Global Financial Crises. University of Cincinnati Law Review 88.2 (Jan. 2020), pp. 397–474.

Huang, Jing. Optimal Stress Tests in Financial Networks. SSRN Electronic Journal (2024). ISSN: 1556-5068. DOI: 10.2139/ssrn.3465799.

I study information design on a financial network to maximize its stability, where banks' endogenous default outcomes are determined by a fixed point payment problem that accounts for both project qualities and interbank contagion. In addition to the cross state risk sharing in previous work, the system-level design highlights the novel cross-bank risk sharing: a less discriminatory disclosure that reports the same signal on different banks reduces contagion, but may be costly due to banks' idiosyncratic shocks. The optimal disclosure is less discriminatory for high bank profitability or large counterpartyexposure. The paper shows tractability in two cases: in the complete network, signals that are reported in the optimal policy must outperform a naive all-pass policy at one particular state; in general networks, when prior is sufficiently low, the optimal policy canbe determined by ranking an efficiency index.

Huang, Wenqian. Central counterparty capitalization and misaligned incentives. BIS Working Papers 767 (2019).

Financial stability depends on the effective regulation of central counterparties CCPs, which must take account of the incentives that drive CCP behavior. This paper studies the incentives of a for-profit CCP with limited liability. It faces a trade-off between fee income and counterparty credit risk. A better-capitalized CCP sets a higher collateral requirement to reduce potential default losses, even though it forgoes fee income by deterring potential traders. I show empirically that a 1% increase in CCP capital is associated with a 0.6% increase in required collateral. Limited liability, however, creates a wedge between its capital and collateral policy and the socially optimal solution to this trade-off. The optimal capital requirements should account for clearing fees.

Huang, Wenqian and Elod Takats. Model risk at central counterparties: Is skin-in-the-game a game changer? BIS Working Papers 866 (May 2020).

We investigate empirically how the balance sheet characteristics of central counterparties (CCPs) affect their modelling of credit risk. CCPs set initial margin (IM), i.e., the collateral for transactions,to limit counterparty credit risk. When a CCP's IM model fails on a large scale, the CCP could fail too, losing its skin-in-the-game capital. We find that higher skin-in-the-game is significantly associated with more prudent modelling, in contrast to profits (a proxy for franchise value) and forms of capital other than skin-in-the-game. The results may help to inform the ongoing policy debate on how to incentivise prudent credit risk management at CCPs.

Huang, Wenqian and Haoxiang Zhu. CCP Auction Design. BIS Working Papers (May 2021).

Central counterparties (CCPs) are systemically important. When a clearing member defaults,the CCP sells the defaulted portfolio to surviving members in an auction, and losses, if any, are partly absorbed by a cash pool prefunded by the surviving members. We propose a tractable auction model that incorporates this salient feature. We find that "juniorization" – the CCP firstuses prefunded cash of members who submit bad bids – increases the auction price. Aggressive juniorization can

push the auction price above the fair value and almost eliminate the need to use prefunded resources. Nonetheless, juniorization generates heterogeneous impact on members of different sizes.

ISDA. *Building resilience and competitiveness of EU derivatives markets: Post-Trade Risk Reduction*. Tech. rep. existing. ISDA, 2020.

Post-Trade Risk Reduction (PTRR) services would significantly strengthen the resilience and competitiveness of Europe's growing derivatives markets, if fully deployed. Their benefits have been clearly acknowledged by the European Securities and Markets Authority (ESMA), in cooperation with the European Systemic Risk Board (ESRB), who have advocated for the creation of a coherent regulatory framework for these services.

Jackson, Matthew O and Agathe Pernoud. *Credit Freezes, Equilibrium Multiplicity, and Optimal Bailouts in Financial Networks*. Tech. rep. 7. arXiv:2012.12861 [physics, q-fin] type: article. arXiv, Jan. 2024, pp. 2017–2062. DOI: 10.1093/rfs/hhad096. arXiv: 2012.12861.

We analyze how interdependencies between organizations in financial networks can lead to multiple possible equilibrium outcomes. A multiplicity arises if and only if there exists a certain type of dependency cycle in the network that allows for self-fulfilling chains of defaults. We provide necessary and sufficient conditions for banks' solvency in any equilibrium. Building on these conditions, we characterize the minimum bailout payments needed to ensure systemic solvency, as well as how solvency can be ensured by guaranteeing a specific set of debt payments. Bailout injections needed to eliminate self-fulfilling cycles of defaults (credit freezes) are fully recoverable, while those needed to prevent cascading defaults outside of cycles are not. We show that the minimum bailout problem is computationally hard, but provide an upper bound on optimal payments and show that the problem has intuitive solutions in specific network structures such as those with disjoint cycles or a core-periphery structure.

— Systemic Risk in Financial Networks: A Survey. Annual Review of Economics 13.1 (2021), pp. 171–202. DOI: 10.1146/annurev-economics-083120-111540. (Visited on 02/03/2023).

We provide an overview of the relationship between financial networks and systemic risk. We present a taxonomy of different types of systemic risk, differentiating between direct externalities between financial organizations (e.g., defaults, correlated portfolios, fire sales), and perceptions and feedback effects (e.g., bank runs, credit freezes). We also discuss optimal regulation and bailouts, measurements of systemic risk and financial centrality, choices by banks regarding their portfolios and partnerships, and the changing nature of financial networks.

Karmel, Roberta S. Turning Seats into Shares: Causes and Implications of Demutualization of Stock and Futures Exchanges. Hastings Law Journal 53.2 (2002), p. 367.

A dramatic shift in the economic and power structure of the securities industry is currently in progress. Traditionally, stock and futures exchanges have operated in the form of non-profit mutual or membership organizations. To the extent market power was not curtailed by competition or regulation, mutual governance gave specialist or market maker members of an exchange control of the price, quality and range of services produced by the exchange. Exchange profits were returned to broker and dealer members in the form of lower access fees or trading profits. Further, exchanges have long operated as self-regulatory organizations (SROs) with members contributing their time to governance and self-regulation to make exchanges more effective and more profitable. Selfregulation was enshrined in the federal securities laws and commodity laws, with oversight by the Securities

and Exchange Commission (SEC) and the Commodity Futures Trading Commission. The pressure to reduce trading execution costs and the demands for technological innovation are among the causes leading to the demutualization of exchanges. These developments are raising many market structure issues. These include regulation of electronic communication networks; market fragmentation; linkages; market information fees and other exchange revenues; the fair treatment of customer orders; and perhaps most importantly, the future of selfregulation. New competitive strategies by exchanges and their members, including demutualization, are raising serious conflicts of interest questions about self-regulation. This Article will argue that the SEC is attempting to re-regulate market structure under a command and control model pursuant to the national market system provisions injected into the Securities Exchange Act of 1934 in 1975 at a time when the monopoly trading regime which led to the national market system mandate is breaking down. An interesting and relevant question this Article will pose is whether current trading technologies and the competition these technologies have engendered should lead to a reduction of SEC market regulation, rather than the increase in regulation envisioned by current SEC concept and rulemaking releases, so that competition rather than regulation can determine outcomes. This Article will also inquire about the future of self-regulation and exchange governance in a world where stock and commodities exchanges are not mutual organizations. Although exchanges have long operated as SROs, there are serious questions as to whether they will be able to continue to do so after demutualization.

King, Thomas et al. Central Clearing and Systemic Liquidity Risk. en. Finance and Economic Discussion Series (May 2022). https://www.federalreserve.gov/econres/feds/central-clearing-and-systemic-liquidity-risk.htm (visited on 02/01/2023).

By stepping between bilateral counterparties, central counterparties (CCPs) transform credit exposure, thereby improving financial stability. But, large CCPs are concentrated and interconnected with major global banks. Moreover, although they mitigate credit risk, CCPs create liquidity risks, because they require participants to provide cash. Such requirements increase with market volatility; consequently, CCP liquidity needs are inherently procyclical. This procyclicality makes it more challenging to assess CCPs' resilience in the rare event that one or more large financial institutions default. Liquidity-focused macroprudential stress tests could help to assess and manage this systemic liquidity risk.

Koeppl, Thorsten V. and Cyril Monnet. Central counterparties. CFS Working Paper Series. CFS Working Paper Series 2008/42 (2008). https://ideas.repec.org/p/zbw/cfswop/200842.html.

Central counterparties (CCPs) have increasingly become a cornerstone of financial markets infrastructure. We present a model where trades are time-critical, liquidity is limited and there is limited enforcement of trades. We show a CCP novating trades implements efficient trading behaviour. It is optimal for the CCP to face default losses to achieve the efficient level of trade. To cover these losses, the CCP optimally uses margin calls, and, as the default problem becomes more severe, also requires default funds and then imposes position limits.

Kress, Jeremy. CREDIT DEFAULT SWAPS, CLEARINGHOUSES, AND SYSTEMIC RISK: WHY CENTRALIZED COUNTERPARTIES MUST HAVE ACCESS TO CENTRAL BANK LIQUIDITY. Harvard Journal on Legislation 48.1 (2009).

Credit default swaps ("CDSs") were widely blamed as a primary cause of therecent financial crisis; CDSs fomented panic as the price of credit protectionspiked and contributed to the Federal

Reserve's decision to bail out AmericanInternational Group. To reduce the likelihood that credit derivatives will lead tofuture financial distress, the Dodd-Frank Wall Street Reform and Consumer ProtectionAct mandates that many CDSs be traded through a centralizedcounterparty, a clearinghouse that acts as a seller to every buyer and a buyer toevery seller. Proponents of central clearing argue that this reform minimizesrisks to the financial system by reducing interconnections and dispersing losses.While the systemic benefits of central clearing are manifest, the downsides areless obvious: clearinghouses concentrate risk and pose enormous threats to financialstability should they fail. Ignoring such drawbacks, several members ofCongress involved in Dodd-Frank negotiations, disturbed by the Federal Reserve'sunprecedented market interventions, sought to revoke the central bank'sauthority to lend to clearinghouses. This Article argues that these imprudentefforts, though ultimately unsuccessful, could have prevented the Federal Reservefrom staving off a catastrophic clearinghouse collapse. This Article assertsthat clearinghouse access to central bank credit is crucial, particularly whencentral clearing of volatile CDSs is required.

Kubitza, Christian, Loriana Pelizzon, and Mila Getmansky Sherman. Loss Sharing in Central Clearinghouses: Winners and Losers. The Review of Asset Pricing Studies 14.2 (Jan. 2024), pp. 237–273. ISSN: 2045-9920. DOI: 10.1093/rapstu/raae002. eprint: https://academic.oup.com/raps/article-pdf/14/2/237/57572204/raae002.pdf.

Central clearing counterparties (CCPs) were established to mitigate default losses resulting from counterparty risk in derivatives markets. In a parsimonious model, we show that clearing benefits are unevenly distributed across market participants. Loss sharing rules determine who wins or loses from clearing. Current rules disproportionately benefit market participants with flat portfolios. Instead, those with directional portfolios are relatively worse off, consistent with their reluctance to voluntarily use central clearing. Alternative loss sharing rules can address cross-sectional disparities in clearing benefits. However, we show that CCPs may favor current rules to maximize fee income, with externalities on clearing participation. (JEL G18, G23, G28, G12).

Li, David, Fernando Cerezetti, and Roy Cheruvelil. Correlation breakdowns, spread positions and central counterparty margin models. The Journal of Financial Market Infrastructures (2024). ISSN: 2049-5412. DOI: 10.21314/jfmi.2024.006.

The default of a member of the Nasdaq Clearing commodities market in 2018 and the Covid-19 events in 2020 brought the importance of appropriately measuring breakdowns in market correlation to the attention of risk managers at central counterparties. The sizable price dislocations registered on these occasions suggested that traditional risk models may not be fully equipped to capture such breakdowns. Because correlations are directly impacted by the statistical properties of each variable, any model that lacks the capacity to deal with nonstationarity may inappropriately represent correlations or their alterations. Using an approach that combines a generalized autoregressive conditional heteroscedasticity model with dynamic conditional correlation (GARCH-DCC) to accommodate such properties, we aim to study correlation behavior during adverse market conditions and the potential impact on central counterparty margins. We propose a case study on energy commodities, with a specific focus on spread positions for the electricity market. The analysis suggests that correlation breakdowns are more frequent than traditionally expected. When different types of shocks (ie, those of September 2018 and March–May 2020) are considered, it becomes evident that while the magnitudes of the breakdowns may differ, their cycles present a number of

similarities. We also recognize the potentially increased margin procyclicality that may be entailed by model corrections to deal with correlation breakdowns, highlighting the challenges of balancing margin responsiveness and stability during adverse market conditions.

Lin, Li and Jay Surti. Capital requirements for over-the-counter derivatives central counterparties. Journal of Banking and Finance 52 (Mar. 2015), pp. 140–155. ISSN: 0378-4266. DOI: 10.1016/j.jbankfin.2014.08.015.

This paper assesses the sensitivity of the risk buffers, or capital requirements, of central counterparties clearing over-the-counter derivatives trades to a range of model inputs. It finds capital requirements to be highly sensitive to whether key model parameters are calibrated on a point-in-time versus stress-period basis, whether the risk tolerance metric adequately captures tail-risk events, and the ability – or lack thereof – to define exposures on the basis of netting sets spanning multiple risk factors. Our results suggest that there are considerable benefits from prudential authorities adopting a more prescriptive approach to central counterparties' risk buffers, in line with recent enhancement of the capital regime for banks' trading books.

Loon, Yee Cheng and Zhaodong (Ken) Zhong. Does Dodd-Frank affect OTC transaction costs and liquidity? Evidence from real-time CDS trade reports. Journal of Financial Economics 119.3 (Mar. 2016), pp. 645–672. ISSN: 0304-405X. DOI: 10.1016/j.jfineco.2016.01.019.

This paper examines transaction costs and liquidity in the index CDS market by matching intraday quotes to real-time trade reports made available through the Dodd-Frank reforms. We find that the average relative effective spread is 0.27% of price level or 2.73% of CDS spread. Dodd-Frank does affect transaction costs and liquidity. Liquidity improves after the commencement of public dissemination of OTC derivatives trades. Moreover, cleared trades, trades executed on exchange-like venues, end-user trades, and bespoke trades exhibit lower trading costs, price impact, and price dispersion. These findings improve our understanding of the OTC derivatives market that is undergoing fundamental changes.

Lopez, Jorge A. Cruz et al. CoMargin. The Journal of Financial and Quantitative Analysis 52.5 (2017), pp. 2183–2215. ISSN: 0022-1090. https://www.jstor.org/stable/26590475 (visited on 03/28/2023).

We present CoMargin, a new methodology to estimate collateral requirements in derivatives central counterparties (CCPs). CoMargin depends on both the tail risk of a given market participant and its interdependence with other participants. Our approach internalizes trading externalities and enhances the stability of CCPs, thus reducing systemic risk concerns. We assess our methodology using proprietary data from the Canadian Derivatives Clearing Corporation that include daily observations of the actual trading positions of all of its members from 2003 to 2011. We show that CoMargin outperforms existing margining systems by stabilizing the probability and minimizing the shortfall of simultaneous margin-exceeding losses.

Magerle, Jurg and Thomas Nellen. Interoperability between central counterparties. Swiss National Bank Working Papers (Nov. 2011).

In reaction to recent requests for interoperability between central counterparties in European stock markets, regulators have issued new guidelines to contain systemic risk. Our analysis confirms that the currently applied cross-CCP reisk management model can be a source of contagion, particularly if applied in multilateral frameworks. While rgulators' new guidelines eliminate systemic risk, this

comes at the cost of an inefficiently overcollateralised clearing system. We discus further approaches that contain systemic risk while reducing or eliminating overcollateralisation. Interoperability is of economic importance as it may contribute to the efficiency and safety of a worldwide fragmented clearing infrastructure.

Markose, Sheri, Simone Giansante, and Ali Rais Shaghaghi. 'Too interconnected to fail' financial network of US CDS market: Topological fragility and systemic risk. Journal of Economic Behavior & Organization 83.3 (May 31, 2012), pp. 627–646. DOI: 10.1016/j.jebo.2012.05.016.

A small segment of credit default swaps (CDS) on residential mortgage backed securities (RMBS) stand implicated in the 2007 financial crisis. The dominance of a few big players in the chains of insurance and reinsurance for CDS credit risk mitigation for banks' assets has led to the idea of too interconnected to fail (TITF) resulting, as in the case of AIG, of a tax payer bailout. We provide an empirical reconstruction of the US CDS network based on the FDIC Call Reports for off balance sheet bank data for the 4th quarter in 2007 and 2008. The propagation of financial contagion in networks with dense clustering which reflects high concentration or localization of exposures between few participants will be identified as one that is TITF. Those that dominate in terms of network centrality and connectivity are called 'super-spreaders'. Management of systemic risk from bank failure in uncorrelated random networks is different to those with clustering. As systemic risk of highly connected financial firms in the CDS (or any other) financial markets is not priced into their holding of capital and collateral, we design a super-spreader tax based on eigenvector centrality of the banks which can mitigate potential socialized losses.

Markose, Sheri M. Systemic Risk from Global Financial Derivatives: A Network Analysis of Contagion and Its Mitigation with Super-Spreader Tax. A Network Analysis of Contagion and Its Mitigation with Super-Spreader Tax. IMF Working Papers. IMF Working Papers Working Paper No. 12/282 (2012).

Financial network analysis is used to provide firm level bottom-up holistic visualizations of interconnections of financial obligations in global OTC derivatives markets. This helps to identify Systemically Important Financial Intermediaries (SIFIs), analyse the nature of contagion propagation, and also monitor and design ways of increasing robustness in the network. Based on 2009 FDIC and individually collected firm level data covering gross notional, gross positive (negative) fair value and the netted derivatives assets and liabilities for 202 financial firms which includes 20 SIFIs, the bilateral flows are empirically calibrated to reflect data-based constraints. This produces a tiered network with a distinct highly clustered central core of 12 SIFIs that account for 78 percent of all bilateral exposures and a large number of financial intermediaries (FIs) on the periphery. The topology of the network results in the "Too- Interconnected-To-Fail" (TITF) phenomenon in that the failure of any member of the central tier will bring down other members with the contagion coming to an abrupt end when the "super-spreaders" have demised. As these SIFIs account for the bulk of capital in the system, ipso facto no bank among the top tier can be allowed to fail, highlighting the untenable implicit socialized guarantees needed for these markets to operate at their current levels. Systemic risk costs of highly connected SIFIs nodes are not priced into their holding of capital or collateral. An eigenvector centrality based "super-spreader" tax has been designed and tested for its capacity to reduce the potential socialized losses from failure of SIFIs.

McLaughlin, Dennis. Skin in the game. Journal of Financial Market Infrastructures 7.1 (2018), pp. 47–55. ISSN: 2049-5404. DOI: 10.21314/jfmi.2018.101.

This paper analyzes the cost of putting aside capital as skin in the game (SITG). It shows first that under the powers granted to a central counterparty (CCP) by its rule-book, the need for CCP capital is primarily driven by the nondefault loss exposure profile, and not necessarily by the quantum of cleared positions. Further, it demonstrates that there is only limited potential to increase the SITG at a CCP, given that it is a private institution that must return the equity cost of capital to the market to continue in business. In practice, this restricts the ability to mandate higher SITG for CCPs, for if no private sector CCP can meet the cost of equity capital, then the clearing solution needs to be provided by the taxpayer, which is an unacceptable outcome. Finally, this paper calculates the trade-off between increasing SITG and increasing clearing costs to members, to compensate the CCP for returns falling below the equity cost of capital. It establishes that a substantial increase in SITG over current levels would require a corresponding substantial increase in clearing fees across the financial sector.

Menkveld, Albert J. Crowded Positions: An Overlooked Systemic Risk for Central Clearing Parties*. The Review of Asset Pricing Studies 7.2 (May 2017), pp. 209–242. ISSN: 2045-9920. DOI: 10.1093/rapstu/rax016. eprint: https://academic.oup.com/raps/article-pdf/7/2/209/24518381/rax016.pdf.

Counterparty risk could hamper trade and worsen a financial crisis. A central clearing party (CCP) insures traders against counterparty default and thus benefits trade. Default of the CCP however becomes a new systemic risk. CCP risk management does not account for risks associated with crowded positions. This paper proposes a CCP exposure measure based on tail risk in trader portfolios. It identifies and measures crowded risk and assigns it to traders according to the polluter pays principle. CCP data show that crowded positions increase CCP exposure most (about one-third) on turbulent days, when exposure is high already.

Menkveld, Albert J. and Guillaume Vuillemey. The Economics of Central Clearing. Annual Review of Financial Economics 13.1 (2021), pp. 153–178. DOI: 10.1146/annurev-financial-100520-100321. (Visited on 12/23/2022).

Central clearing counterparties (CCPs) have a variety of economic rationales. The Great Recession of 2007–2009 led regulators to mandate CCPs for most interest-rate and credit derivatives, markets in which large amounts of risks are transferred across agents. This change led to a large increase in CCP studies, which along with classical studies are surveyed in this article. For example, multilateral netting, the insurance against counterparty risk, the effect of CCPs on asset prices and fire sales, margins setting, the default waterfall, and CCP governance are discussed here. We review both CCP theory and empirical work and conclude by discussing regulatory issues.

Metrick, Andrew and Daniel Tarullo. Congruent Financial Regulation. Brookings Papers on Economic Activity (2021), pp. 143–181. ISSN: 00072303, 15334465. https://www.jstor.org/stable/27093823.

After the global financial crisis, bank regulation became more stringent, and as a result the traditional banking system was well capitalized leading into the COVID-19 pandemic. But these same regulatory changes also incentivized a continuing migration of traditional banking activities to non-bank financial institutions (NBFIs), where looser regulation allowed for dangerous buildups of sys-

temic risk. These risks were then realized across many NBFIs and markets in 2020. While legislation to harmonize regulation across these different domains would be desirable, we do not believe it likely in the foreseeable future. In this paper we propose a congruence principle for financial regulation, whereby regulators use existing statutory authority to coordinate rules across economically similar instruments. We provide examples of how such congruence could work for the cases of nonprime mortgage finance and the markets for US Treasury securities.

Murphy, David. The systemic risks of OTC derivatives central clearing. Journal of Risk Management in Financial Institutions 5.3 (2012), pp. 319–334. https://EconPapers.repec.org/RePEc:aza:rmfi00:y:2012:v:5:i:3:p:319-334.

This paper examines the changes to systemic risk made by the introduction of over the counter derivatives central clearing. It discusses both the reductions in exposure brought about by the introduction of central counterparties (CCPs) as buffers between derivatives counterparties, and the risks posed by the potential for a CCP failure. In particular, this paper studies both the solvency risks whereby a CCP might sustain sufficient losses to be unable to continue operations, and liquidity risks whereby the failure of a CCP or one of its members may be caused by an inability to meet claims. Based on this analysis, possible mitigants are suggested to the principal systemic risks posed by central clearing.

— I've got you under my skin: large central counterparty financial resources and the incentives they create. The Journal of Financial Market Infrastructures 5.3 (Mar. 2017). ISSN: 2049-5404. DOI: 10.21314/jfmi.2017.073.

This paper introduces a simple model of the default waterfall of a central counterparty (CCP) clearing service to provide an objective analysis of its composition. The three commonly found elements of the waterfall (initial margin, CCP capital at risk or "skin-in-the-game" (SITG), and default fund (DF)) are introduced, and the impact of varying the proportions of each element is discussed. The model suggests that, under reasonable assumptions, CCPs want SITG to be as low as possible, while clearing members prefer services where it plays a larger role in the default waterfall. In our setting, lower levels of SITG lead to a higher CCP return on equity but reduced levels of clearing. Moreover, CCPs have an incentive to keep initial margin higher than the required minimum, as this reduces the risk of DF losses without putting CCP capital at risk. The analysis presented suggests that a regulatory minimum requirement for SITG could play a role in incentivizing the use of CCPs where a clearing mandate does not apply and regulatory capital incentives to clear do not bite.

Norman, Peter. *The Risk Controllers: Central Counterparty Clearing in Globalised Financial Markets. Central counterparty clearing in globalised financial markets*. Includes bibliographical references (p. [361]-373) and index. - Description based on print version record. Chichester, U.K.: Wiley, Jan. 2012. 1400 pp. ISBN: 9781119205913. DOI: 10.1002/9781119205913.

Clearing houses, or CCPs, were among the very few organisations to emerge from the global financial crisis with their standing enhanced. In the chaotic aftermath of the bankruptcy of Lehman Brothers, they successfully completed trades worth trillions of dollars in a multitude of financial instruments across listed and over-the-counter markets, and so helped avert financial Armageddon. That success transformed the business of clearing. Governments and regulators around the world gave CCPs and the clearing services they provide a front-line role in protecting the global economy from future excesses of finance. CCPs, which mitigate risk in financial markets, responded by

greatly expanding their activities, notably in markets for over-the-counter derivatives, and often in fierce competition with one another. In The Risk Controllers, journalist and author Peter Norman describes how CCPs operate, how they handled the Lehman default, and the challenges they now face. Because central counterparty clearing is a complex business with a long history that continues to influence decisions and structures even in today's fast changing world, The Risk Controllers explores the development of CCPs and clearing from the earliest times to the present. It draws on the experiences of the people who helped to shape the business of clearing today. It sets the development of CCPs and clearing in the broader context of changes in society, politics and regulation. The book examines turning points, such as the 1987 stock market crash, that set clearing on a new path and the impact of long running trends, including the exponential growth of computer power and the ebb and flow of globalisation. Written in non-technical language, The Risk Controllers provides a unique and accessible guide to CCPs and clearing. It is essential reading for clearing professionals, legislators and regulators whose job it is to take this vitally important business into the future.

Paddrik, Mark, Sriram Rajan, and H. Peyton Young. Contagion in Derivatives Markets. Management Science 66.8 (Aug. 2020), pp. 3603–3616. ISSN: 1526-5501. DOI: 10.1287/mnsc.2019.3354.

A major credit shock can induce large intraday variation margin payments between counterparties in derivatives markets, which may force some participants to default on their payments. These payment shortfalls become amplified as they cascade through the network of exposures. Using detailed Depository Trust & Clearing Corporation data, we model the full network of exposures, shock-induced payments, initial margin collected, and liquidity buffers for about 900 firms operating in the U.S. credit default swaps market. We estimate the total amount of contagion, the marginal contribution of each firm to contagion, and the number of defaulting firms for a systemic shock to credit spreads. A novel feature of the model is that it allows for a range of behavioral responses to balance sheet stress, including delayed or partial payments. The model provides a framework for analyzing the relative effectiveness of different policy options, such as increasing margin requirements or mandating greater liquidity reserves.

Paddrik, Mark and H Peyton Young. How Safe are Central Counterparties in Derivatives Markets? OFR Working Paper Series (Nov. 2, 2017).

We propose a general framework for estimating the likelihood of default by central coun-terparties (CCP) in derivatives markets. Unlike conventional stress testing approaches, whichestimate the ability of a CCP to withstand nonpayment by its two largest counterparties, westudy the direct and indirect e ects of nonpayment by members and/or their clients throughthe full network of exposures. We illustrate the approach for the credit default swaps (CDS)market under shocks that are similar in magnitude to the Federal Reserve's 2015 Comprehen-sive Capital Analysis and Review trading book shock. The analysis indicates that conventionalstress testing approaches may underestimate the potential vulnerability of the main CCP forthis market.

Paddrik, Mark and Peyton H. Young. Assessing the Safety of Central Counterparties. OFR Working Paper Series (July 14, 2021). https://www.financialresearch.gov/working-papers/2021/06/09/assessing-the-safety-of-central-counterparties/.

We propose a general framework for empirically assessing a central counterparty's capacity to cope with severe financial stress. Using public disclosures data for global central counterparties (CCPs), we show how to estimate the probability that a CCP could cover any specified fraction

of payment defaults by its members. This framework supplements conventional standards of risk management such as Cover 2 and provides a comparative and comprehensive approach to assessing risk protection across CCPs that is not predicated on a specific number of member defaults. We apply the approach to a wide range of CCPs in different geographical jurisdictions and asset classes and find that there are substantial differences in protection coverage. In particular, large European CCPs appear to be significantly safer than their counterparts in Asia-Pacific and North America. These differences are also reflected in supervisory data that provide CCP members' risk assessments of the CCPs to which they belong.

Paddrik, Mark and Simpson Zhang. Central Counterparty Default Waterfalls and Systemic Loss. en. OFR Working Paper Series (June 2020). https://www.financialresearch.gov/working-papers/2020/06/18/central-counterparty-default-waterfalls-and-systemic-loss/ (visited on 01/19/2023).

This paper examines how a central counterparty (CCP) uses a default waterfall to manage and allocate resources to cover defaults of clearing members and clients. A resilient waterfall ensures cleared payments are paid in full and on-time, reducing the threat to financial stability from losses and their spillovers. However, the amount of resources collected and their allocation affect clearing incentives. This paper models and evaluates the trade-offs between resiliency and participation in a credit default swaps market. It finds that the benefits of greater central clearing rates generally dominate the benefits of increased waterfall resources. (Working Paper no. 20-4).

Peirce, Hester. Derivatives Clearinghouses: Clearing the Way to Failure. Cleveland State Law Review 64.3 (2016), p. 589.

One of the major components of Dodd-Frank was a comprehensive regulatory framework for over-the-counter derivatives. A key feature of this framework is a requirement that many of these derivatives be cleared through central counterparty clearinghouses. Clearinghouses have long played a stabilizing force in many markets, but Dodd-Frank's regulatory mandate may adversely affect the way they operate. Risk management by clearinghouses and market participants could suffer, and improper risks could find their way into clearinghouses. If a clearinghouse were to fail, there would be tremendous pressure for the government to bail it out in the name of financial stability. Dodd-Frank's derivatives framework should be reconsidered before it destabilizes the financial system. A better approach would empower market participants to decide whether to use clearinghouses and would allow clearinghouses the regulatory latitude to effectively manage their risks.

Pirrong, Craig. The Economics of Clearing in Derivatives Markets: Netting, Asymmetric Information, and the Sharing of Default Risks Through a Central Counterparty. en. SSRN Electronic Journal 1340660 (Jan. 2009). DOI: 10.2139/ssrn.1340660. https://papers.ssrn.com/abstract=1340660 (visited on 03/27/2023).

Credit derivatives have received intense scrutiny – and criticism – as a major contributor to the ongoing financial crisis. In response, regulators have proposed requiring the formation of a central clearinghouse to share default risk on these contracts. A comparative economic analysis of the costs and benefits of alternative default risk sharing mechanisms casts considerable doubt on the advisability of central clearing of credit derivatives. These products are likely to be subject to severe information asymmetry problems regarding their value, risk, and the creditworthiness of those who trade them, and these information asymmetries are likely to be less severe in bilateral markets than

in centrally cleared systems. Moreover, although regulators have argued that clearing would reduce systemic risk, a more complete analysis demonstrates that clearing could actually increase risks to the broader financial system.

Pirrong, Craig. The Economics of Central Clearing: Theory and Practice. ISDA Discussion Paper Series 1 (May 2011).

Research, Office of Financial. *The Life of the Counterparty: Shock Propagation in Hedge Fund-Prime Broker Credit Networks | Office of Financial Research*. en. Dec. 2022. DOI: 10.1016/j.jfineco.2022.02.002. https://www.financialresearch.gov/working-papers/2019/10/01/the-life-of-the-counterparty/ (visited on 03/08/2023).

This paper shows the post-crisis hedge fund-prime broker credit network is concentrated among 10 percent of participants. The average fund borrows from three brokers, and the brokers lending the most are highly connected. The paper finds that a liquidity shock to a prime broker results in reduced borrowing by hedge funds due to the broker reducing its supply of credit. Larger, more connected, and better-performing funds, and those that do less over-the-counter trading, are better able to compensate for the reduction in credit from the broker. (Working Paper no. 19-03).

Saguato, Paolo. The Ownership of Clearinghouses: When Skin in the Game Is Not Enough, the Remutualization of Clearinghouses. Yale Journal on Regulation 34 (2017).

A central question for corporate law scholarship has revolved around the ownership structure of enterprises. Why are some businesses owned by employees, some by customers, and some by investors? Until now, the question has centered on the relative benefits offered to these stakeholders by one form or another. This Article explores how ownership structure can be a matter of public importance for financial stability, and proves that it is so by delving into an institution of immense importance and timeliness: the clearinghouse, a critical financial market infrastructure. Clearinghouses process, settle, and guarantee the performance of several trillion dollars in securities and derivatives trades daily. By operating as central counterparties, they act as private stability mechanisms, reducing counterparty credit risk and sharing default risk among their members. Clearinghouses achieve this result via a unique economic structure, which includes a double layer of capital: the traditional equity capital and the so-called mutual guaranty fund (the clearinghouse's loss sharing fund). Historically, clearinghouses have been mutual enterprises owned by their members (users), who contributed to the firm's mutual guaranty fund. But most clearinghouses have recently demutualized their ownership structure, opening their equity capital to external investors and transforming into for-profit public corporations, while keeping members on the hook for losses. This structural evolution has catalyzed new agency costs between the now coexisting and "competing" stakeholders: members and external shareholders. These costs, which have been further exacerbated by the post-crisis systemic role of clearinghouses, are exemplified by shareholders with control and economic rights but limited "skin in the game," and members who bear the final risk and losses if things go south, but who have no control or monitoring rights. This Article identifies how the agency costs between members and shareholders threaten the financial stability of clearinghouses and argues that aligning control and monitoring rights with final risk-bearing costs is the path clearinghouses should follow to achieve a more resilient ownership and governance structure.

Scott, Kenneth E., Thomas H. Jackson, and John Taylor, eds. *Making Failure Feasible*. Hoover Institution, Stanford University, 2015. https://EconPapers.repec.org/RePEc:hoo:books1:9.

In 2012, building off work first published in 2010, the Resolution Project proposed that a new Chapter 14 be added to the Bankruptcy Code, exclusively designed to deal with the reorganization or liquidation of the nation's large financial institutions. In Making Failure Feasible, the contributors expand on their proposal to improve the prospect that our largest financial institutions—particularly with prebankruptcy planning—could be successfully reorganized or liquidated pursuant to the rule of law and, in doing so, both make resolution planning pursuant to Title I of Dodd-Frank more fruitful and make reliance on administrative proceedings pursuant to Title II of Dodd-Frank largely unnecessary. This book highlights the problems of dealing with large financial institutions in distress, without incurring either spillover distress to other institutions or relying on government bailout, and Chapter 14's responses to those twin issues, as well as recommending other measures that would facilitate successful resolutions. The contributors first outline the basic features of Chapter 14 as originally proposed in 2012 vis-à-vis the reorganization or liquidation of an operating company and point to their continuation as well as additional features to ensure the quick resolution of large financial institutions that would not depend on government discretion and would mesh with emerging ideas about cross-border resolution. The remaining chapters provide the context for reform, outline the fundamental principles of reform, show how reform would work in practice, and show how Chapter 14, as envisioned in this book, would be a substantial advance on administrative-focused resolution procedures.

Squire, Richard. Clearinghouses as Liquidity Partitioning. Cornell Law Review 857 (2014).

To reduce the risk of another financial crisis, the Dodd-Frank Actrequires that trading in certain derivatives be backed by clearinghouses. Criticsmount two main objections: a clearinghouse shifts risk instead of reducingit; and a clearinghouse could fail, requiring a bailout. This Article'sobservation that clearinghouses engage in liquidity partitioning answersboth. Liquidity partitioning means that when one of its member firms becomesbankrupt, a clearinghouse keeps a portion of the firm's most liquidassets, and a matching portion of its short-term debt, out of the bankruptcyestate. The clearinghouse then applies the first toward immediate repaymentof the second. Economic value is created because creditors within theclearinghouse are paid much more quickly, and other creditors are paid noless quickly, than they would be otherwise. The rapid cash payouts forclearinghouse members reduce illiquidity and uncertainty in the financialsector, the main causes of contagion in a crisis. And because the clearinghouseholds only liquid assets, it avoids the maturity mismatch betweenshort-term liabilities and long-term assets that characterizes the balance sheetsof many financial institutions. A clearinghouse therefore is much less likelythan its members to fail during a crisis. To ensure that clearinghouses remainstable and systemically valuable, rulemakers should require clearing ofa wide variety of derivatives contracts, but should limit clearinghouse membershipto dealer firms.

Steigerwald, Robert. Understanding Derivatives: Markets and Infrastructure. Federal Reserve Bank of Chicago, 2013. Chap. Central Counterparty Clearing, pp. 12–26.

Turing, Dermot. Central counterparties: magic relighting candles? Journal of Financial Market Infrastructures (2019). ISSN: 2049-5404. DOI: 10.21314/jfmi.2019.114.

Central counterparties (CCPs) that exhaust available financial resources when managing a major default have limited options. In this paper, the rules of selected major CCPs (LCH, CME, Eurex and ICE) are reviewed for both their end-of-waterfall procedures and the rights granted to clearing

members in end-of-waterfall scenarios. These are compared against the arrangements for and resolution policies of CCPs. CCPs have arrangements to boost their financial position even at the end of the waterfall, but these are limited in scope, reflecting clearing members' concerns about unlimited liability. However, it is difficult to put CCPs into a formal insolvency process as well as complex for members to leave a failing CCP. The twin policies of mandatory clearing of over-the-counter derivatives and reviving CCPs post-default may conflict with the rules of CCPs. A revised policy approach is advocated.

Veraart, Luitgard Anna Maria. Distress and default contagion in financial networks. Mathematical Finance 30.3 (Apr. 2020), pp. 705–737. ISSN: 1467-9965. DOI: 10.1111/mafi.12247.

We develop a new model for solvency contagion that can be used to quantify systemic risk in stress tests of financial networks. In contrast to many existing models, it allows for the spread of contagion already before the point of default and hence can account for contagion due to distress and mark-to-market losses. We derive general ordering results for outcome measures of stress tests that enable us to compare different contagion mechanisms. We use these results to study the sensitivity of the new contagion mechanism with respect to its model parameters and to compare it to existing models in the literature. When applying the new model to data from the European Banking Authority, we find that the risk from distress contagion is strongly dependent on the anticipated recovery rate. For low recovery rates, the high additional losses caused by bankruptcy dominate the overall stress test results. For high recovery rates, however, we observe a strong sensitivity of the stress test outcomes with respect to the model parameters determining the magnitude of distress contagion.

— When does portfolio compression reduce systemic risk? Mathematical Finance 32.3 (Mar. 2022), pp. 727–778. ISSN: 1467-9965. DOI: 10.1111/mafi.12346.

We analyze the consequences of portfolio compression for systemic risk. Portfolio compression is a post-trade netting mechanism that reduces gross positions while keeping net positions unchanged and it is part of the financial legislation in the United States (Dodd-Frank Act) and in Europe (European Market Infrastructure Regulation). We derive necessary structural conditions for portfolio compression to be harmful and discuss policy implications. We show that any potential harmfulness of portfolio compression arises from contagion effects. We show how portfolio compression affects systemic risk depends on the resilience of nodes taking part in compression, on the proportion of debt that they can repay, and on the recovery rates in case of default. In particular, the potential danger of portfolio compression comes from defaults of firms that conduct portfolio compression. If no defaults occur among the firms that engage in compression, then portfolio compression always reduces systemic risk.

Veraart, Luitgard Anna Maria and Iñaki Aldasoro. Systemic risk in markets with multiple central counterparties. Mathematical Finance 35.1 (Aug. 2024), pp. 214–262. ISSN: 1467-9965. DOI: 10.1111/mafi.12446.

We provide a framework for modeling risk and quantifying payment shortfalls in cleared markets with multiple central counterparties (CCPs). Building on the stylized fact that clearing membership is shared among CCPs, we develop a modeling framework that captures the interconnectedness of CCPs and clearing members. We illustrate stress transmission mechanisms using simple examples as well as empirical evidence based on calibrated data. Furthermore, we show how stress mitigation tools such as variation margin gains haircutting by one CCP can have spillover effects on other

CCPs. The framework can be used to enhance CCP stress-testing, which currently relies on the "Cover 2" standard requiring CCPs to be able to withstand the default of their two largest clearing members. We show that who these two clearing members are can be significantly affected if one considers higher-order effects arising from interconnectedness through shared clearing membership. Looking at the full network of CCPs and shared clearing members is, therefore, important from a financial stability perspective.

Vuillemey, Guillaume. Mitigating fire sales with a central clearing counterparty. Journal of Financial Intermediation 55 (July 2023), p. 101045. ISSN: 1042-9573. DOI: 10.1016/j.jfi.2023.101045.
Theoretically, one rationale for central clearing counterparties is the mitigation of inefficiencies associated with distressed asset sales. With novel archival data, I empirically study the first event in economic history during which a CCP successfully played this role: the global wool crisis of 1900. In the leading wool futures market in France, an inefficient equilibrium with fire sales and cascading defaults could be avoided due to price support provided by surviving CCP members. Cooperation to achieve price support–which is nowadays the main element of CCP auctions–could arise due to family relationships and cultural proximity between traders.

Wang, Jessie, Agostino Capponi, and Hongzhong Zhang. A Theory of Collateral Requirements for Central Counterparties. Management Science (June 6, 2021).
This paper develops a framework for designing collateral requirements in a centrally cleared market. Clearing members post collateral-initial margins and default fundsto increase their pledgeable income, thereby committing to risk management. The two types of collateral, however, are not perfect substitutes. By achieving loss mutualization, default funds are economically more efficient than initial margins in aligning members' incentives for risk management ex ante. The optimal mix of collateral resources balances the efficiency in providing incentives with their relative opportunity costs. Our model predicts increased use of initial margins under stringent capital requirements, and of default funds under distressed market scenarios.

Wiggins, Rosalind and Andrew Metrick. The Lehman Brothers Bankruptcy G: The Special Case of Derivatives. Journal of Financial Crises (2019).
When it filed for bankruptcy protection in September 2008, Lehman Brothers was an activeparticipant in the derivatives market and was party to 906,000 derivative transactions of alltypes under 6,120 ISDA Master Agreements with an estimated notional value of $35 trillion.The majority of Lehman's derivatives were bilateral agreements not traded on an exchange but in the over-the-counter (OTC) market. Because derivatives enjoyed an exemption from the automatic stay provisions of the U.S. Bankruptcy Code, parties to Lehman's derivatives could seek resolution and self-protection without the guidance and restraint of thebankruptcy court. The rush of counterparties to novate Lehman's derivative contracts and the confusion following contracts that were terminated after its bankruptcy filing added to the stress of the financial crisis in two ways: (1) loss of value to the Lehman estate and (2) exacerbation of the contagion effects of the bankruptcy. This case explores the disposition of Lehman's derivatives and its impacts.

Wolkoff, Neal L. and Jason B. Werner. History of Regulation of Clearing in the Securities and Futures Markets, and its Impact on Competition. Review of Banking and Financial Law 30 (2010), pp. 313–381.

Yadav, Yesha. The Problematic Case of Clearinghouses in Complex Markets. Georgetown Law Journal 101 (2013), p. 387.

This Article challenges the academic and policy consensus that clearinghousesa dequately mitigate the risks of trading credit derivatives. The Articleadvances two arguments. First, scholars have devoted little attention to the risks posed by underlying assets (such as mortgage loans) that the credit derivative references and the impact that these risks have on the clearinghouse. Credit derivatives enable the economic risk of debt to be separated from the legal rights attaching to that debt. This separation affects the clearinghouse profoundly. As a contract party to each trade it processes, the clearinghouse can be saddled with the economic risk of underlying debt without the legalrights necessary to mitigate its exposure. If a clearinghouse cannot manageits risks, the consequences are invariably systemic and enormously costly to the taxpayer Second, the Article shows that the clearinghouse's structure exposes its members to complex incentives that (1) encourage risk taking by subsidizing and mutualizing default losses; (2) shift the private costs of monitoring to the clearinghouse and thereby allow members to underinvest in due diligence; and (3) cause members to place undue reliance on information provided by third parties that is often colored by the strategic motives of the partiesproviding it. This Article concludes with a proposal for a new paradigm for the clearinghouse.This new model seeks to repair the consequences of separating economic risks from legal rights, which are caused by the use of the credit derivative. It also seeks to mitigate the distorted incentives affecting clearinghouse members. With reforms in place that allow for improved policing of its exposures, the clearinghouse will become a more robust institution that is better positioned to control lax underwriting standards accompanying the extension of credit.

Yadav, Yesha and Joshua Younger. Central Clearing the U.S. Treasury Market. The University of Chicago Law Review 92.2 (2025), pp. 545–596. ISSN: 00419494, 1939859X. https://www.jstor.org/stable/27366575.