

## Research Paper

# Who pays? Who gains? Central counterparty resource provision in the post-Pittsburgh world

**Fernando Cerezetti,<sup>1</sup> Jorge Cruz Lopez,<sup>2</sup> Mark Manning<sup>3</sup> and David Murphy<sup>4</sup>**

<sup>1</sup>ICE Clear Europe, Milton Gate, 60 Chiswell Street, London EC1Y 4SA, UK; email: [Fernando.Cerezetti@theice.com](mailto:Fernando.Cerezetti@theice.com)

<sup>2</sup>Bank of Canada, 234 Wellington Street, Ottawa, ON K1A 0G9, Canada; email: [jcruzlopez@bankofcanada.ca](mailto:jcruzlopez@bankofcanada.ca)

<sup>3</sup>Financial Conduct Authority, 12 Endeavour Square, London E20 1JN, UK; email: [mark.manning@fca.org.uk](mailto:mark.manning@fca.org.uk)

<sup>4</sup>Bank of England, Threadneedle Street, London EC2R 8AH, UK; email: [David.Murphy@bankofengland.co.uk](mailto:David.Murphy@bankofengland.co.uk)

(Received September 17, 2018; accepted February 1, 2019)

## ABSTRACT

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.

**Keywords:** CCP resolution; central counterparties; central clearing; financial regulation; OTC derivatives; systemic risk.

## 1 INTRODUCTION

There has been a wave of regulatory change since the global financial crisis. Notable among the changes is a range of reforms in over-the-counter (OTC) derivatives markets, with the primary objective of promoting financial stability. As part of this, at the G20 Pittsburgh Summit in 2009, there was a declaration that “all standardised OTC derivatives should be . . . cleared through central counterparties (CCPs)” (see G20 2009). Policies have since been implemented to meet this objective, including the introduction of clearing mandates for a range of OTC derivatives in all major jurisdictions.

Such mandates, which imply the use of CCPs as a macroprudential tool, have fundamentally transformed the profile and distribution of counterparty risk across the financial system. Dealer banks’ exposures to CCPs are now amongst their largest, and the capital and collateral needed to support them have risen substantially (Cruz Lopez 2016). Similarly, banks’ contingent exposures to CCPs’ unfunded losses are now sizeable enough to influence bank decision making.

Recognizing the increased systemic importance of CCPs, international standard setters have embarked on a program to enhance the regulatory standards governing these infrastructures. Such standards aim at improving resilience in various ways, and focus prominently on increasing CCPs’ prefunded financial resources. Should these resources prove insufficient to absorb losses, the standards call for comprehensive mechanisms to address the issue. In practice, these mechanisms usually involve allocating losses to the members of the CCP. Loss allocation supports the continuous provision of critical services, but it risks spreading shocks beyond the CCP.

CCPs have traditionally adopted a mutualized model for resource provision, whereby clearing members are required to absorb losses caused by many of the risks

managed by the CCP. However, as the reforms have been rolled out, exposures have increased and tensions have emerged between CCP owners, regulators and clearing members. This has led some to question whether the traditional model of resource provision remains appropriate in a world of mandatory clearing, where joining a CCP and signing up to its “club rules” (including rules that can result in substantial contingent exposure for the member) is no longer a private choice (Rundle 2016).

We argue that most of these tensions can be explained by a misalignment between the policy goal (namely, financial stability) and the particular mechanism chosen to deliver on this goal (namely, central clearing through CCPs as they are currently organized). Specifically, we note that in most cases the design of CCPs, and their model for resource provision in particular, makes them suitable for managing “club goods”, where access can be excluded to nonpaying market participants. Financial stability, however, is a “public good”, which allows all market participants to benefit from it. 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.

As others have noted (Kroszner 2006; Moser 1998), CCP clearing has evolved over time, adapting to a variety of market and regulatory factors, to eventually settle on the model we most commonly observe today. In this paper, we develop a conceptual framework to examine whether the regulatory changes since the Pittsburgh Summit could be a catalyst for reconsidering the structure of clearing houses. In particular, we present an analysis of the functional elements of a CCP to examine whether an alternative clearing model might be more effective in supporting the macroprudential policy goal of the Pittsburgh commitment. We conclude that the observed tension could be mitigated by unbundling the functions of a CCP and selecting the ownership and funding structure that best suits their individual characteristics. We observe that the administration of functions that are critical for the provision of the public good of financial stability, which benefits society at large, might imply some form of public sector involvement, whereas other services better lend themselves to a purely for-profit or a traditional club model. A straw-man proposal is set out to stimulate debate on these considerations.

The remainder of this paper is structured as follows. We begin with some observations about the current risk characteristics of CCPs and how they have evolved in response to post-crisis reforms. In particular, we describe the circumstances in which CCPs could impose systemic risk externalities. Section 3 considers how these externalities are managed in alternative CCP operating models and exposes the tension that such models may create. Section 4 explores this tension in more detail, distinguishing between the loss allocation arrangements that would apply to default losses and those that would apply to nondefault losses. Section 5 introduces our functional

analysis of central clearing, observing that the application of different operating models for certain central clearing functions could help resolve some of the tension in the current model. Section 6 concludes.

## **2 CENTRAL COUNTERPARTY RISK CHARACTERISTICS AND TENSIONS IN THE POST-PITTSBURGH MODEL OF CLEARING**

The fundamental purpose of a CCP is to centralize the management of counterparty risk to insure traders against nonperformance of their counterparties (see Manning and Hughes (2016), Murphy (2013) and Pirrong (2011) for more details). As noted in Cœuré (2017, p. 98), “as long as CCPs are superior risk managers and act as pillars of strength rather than sources of contagion during potential crisis situations, they act as risk poolers, not risk takers, and they therefore reduce the overall level of risk in the global financial system”. That is, a well-designed and effectively operated CCP can deliver material systemic-risk-reduction benefits, including the multilateral netting of exposures, the *ex ante* collateralization of exposures to a high level, transparent and contractually agreed loss allocation to deal with far-tail risks, and coordinated default management. Indeed, it was the pursuit of these benefits that motivated the Pittsburgh declaration.

However, a poorly designed CCP could, in some circumstances, create and transmit risk rather than absorb it. This section discusses how CCPs can be both positive and negative forces for financial stability and considers possible tensions arising from their design.

### **2.1 CCP risk characteristics**

Several authors (see, for example, Gregory 2014; Murphy 2012; Pirrong 2011, 2014) identify some of the channels by which a CCP could create or amplify systemic risk. These include liquidity risk creation (perhaps through margin or collateral haircut procyclicality); the transmission of stress should a CCP’s prefunded resources prove insufficient to cover losses in the event of one or more member defaults; risk shifting, as netting of cleared trades frees members’ balance-sheet capacity to take risks elsewhere; “wrong time” risk (in that mutualized loss allocation is likely to crystallize precisely when members are least able to bear it); and information and incentive issues arising from the mispricing of individual members’ contributions to risk.

Given the risk-reducing benefits of a CCP and the potential channels for transmission of stress, each individual trade submitted for clearing may be regarded as potentially carrying with it both positive and negative systemic externalities. On the one hand, each trade cleared contributes to the opportunities for multilateral netting of exposures, thereby reducing the quantum of risk to be managed relative to a non-centrally cleared counterfactual (Duffie and Zhu 2011). On the other hand, for a given

design, each additional trade potentially increases the quantum of risk controlled by the CCP and thus the potential systemic spillover should a default or nondefault shock arise that needs to be managed. Simply put, the more trades a CCP clears, the bigger the opportunity for multilateral netting and for exploiting the other benefits of clearing, but the larger the potential impact of CCP stress.

Some crucial factors affecting CCP risk are exogenous to the clearing house. For instance, it is ultimately the members, not the CCP, that determine the flow of trades submitted for clearing and, therefore, the quantum of risk to be managed. However, the CCP's design choices – taken within the parameters of the prevailing regulatory architecture and internal governance arrangements – can influence the cost of clearing and members' decisions and ultimately determine the balance of positive and negative systemic externalities that the CCP imposes on the financial system. Who pays for the guarantee that a CCP provides is a fundamental design choice. Since loss allocation arrangements can drive members' behavior, such design choices may prove systemically significant (see Budding and Murphy (2014) for a discussion of this and other design choices in central clearing).

## 2.2 Tensions in the post-Pittsburgh model of clearing

CCPs grew up in association with mutualized exchanges. As such, the usual CCP model includes both an element of mutualized loss allocation (Norman 2011) and some role for clearing members in CCP risk governance. Over time, tensions have arisen in this feature. In particular, as the exchanges demutualized in the 1980s and 1990s, so did the clearing houses that supported them. Nevertheless, they retained their mutualized loss allocation arrangements (Cox and Steigerwald 2016).

As the post-Pittsburgh reforms have been implemented and the sizes of banks' exposures to CCPs have grown, banks' commitments to CCP loss allocation arrangements have come under increasing scrutiny. These exposures have become substantially larger as central clearing has become more prevalent. Revised CCP recovery and resolution arrangements have also increased banks' exposures. A particular source of concern for some commentators in this context has been CCPs' allocation of unfunded losses and reliance on the contingent provision of funds from clearing members (JPMorgan Chase 2017) and, in the extreme, their clients (Blackrock 2016).

More generally, as the quantum of risk to be managed has risen and the systemic importance of CCPs has increased, policy makers and industry participants alike have sought reassurance that the design of CCPs' risk frameworks is adequate to manage the potential systemic consequences of risk concentration. Therefore, calls for tighter regulatory standards for CCP risk management have also grown louder (Cœuré 2014,

2015; ISDA 2015; JPMorgan Chase 2014; Murphy 2012; Powell 2014; Tucker 2011, 2014).

It should be noted that risk concentration in CCPs is a deliberate, and indeed inherent, outcome of the policy drive toward central clearing. It is a feature, not a bug. The provision of CCP services is an economies of scale business. Features such as netting efficiencies and insurance benefits are increasing in the breadth of the CCP's network. It is precisely in recognition of the associated systemic risk implications of concentration that the international regulatory bodies the Committee on Payments and Market Infrastructures (CPMI) and the International Organization of Securities Commissions (IOSCO) introduced the Principles for Financial Market Infrastructures (PFMI) in 2012 (CPMI–IOSCO 2012).<sup>1</sup>

However, while the PFMI set exacting standards for CCP risk governance and financial and operational resilience, there is a fundamental source of tension in the current model that is perhaps underappreciated. That is, in the post-Pittsburgh world, CCPs are effectively being used as a macroprudential policy tool in pursuit of financial stability. They have grown in size and systemic importance, and the benefits derived from their resilience extend beyond the narrow markets in which they operate. Accordingly, in contributing to loss allocation arrangements designed to ensure that a CCP can operate continuously and absorb stress in all – even beyond plausible – market conditions, clearing members no longer simply provide a mutual guarantee for the benefit of each other. Rather, they also provide a guarantee for the sake of the much wider good of financial stability that benefits society in general.

Of course, while the central clearing of OTC derivatives is an obligation, doing so as a direct clearing member is not. Rather, an entity may choose to access a CCP indirectly as a client. However, clearing as a client poses its own problems in the post-Pittsburgh world. First, the capital requirements for clearing exposures as a client discourage this mode of access. Second, under most CCPs' rulebooks, clients often bear at least some of the costs of recovery mechanisms.<sup>2</sup> This comes

---

<sup>1</sup> The PFMI and associated further guidance have sought to enhance resilience by adding further rigour to CCPs' risk-governance arrangements, margin practices and stress-testing models. Further, the PFMI require that CCPs establish comprehensive arrangements to address unfunded losses should prefunded resources prove insufficient. By requiring that CCPs consider all potential sources of risk, the PFMI also illuminate the potential for CCPs to experience losses unrelated to member default, so-called nondefault losses. The PFMI have since been rolled out in each CPMI–IOSCO member's legal and regulatory frameworks (CPMI–IOSCO 2017c), and there has been an extended program of work to further enhance the international regulatory standards that apply to CCPs (BCBS–CPMI–FSB–IOSCO 2017b; CPMI–IOSCO 2017a; FSB–BCBS–CPMI–IOSCO 2015).

<sup>2</sup> For instance, variation margin gains haircutting (VMGH) is a loss allocation tool that is included in a number of CCPs' recovery plans (see CPMI–IOSCO 2016). This too could impose losses disproportionately on clients, since they may be more likely to have directional cleared positions

without a direct influence in the managerial decisions of the CCP. As such, it would seem to be in conflict with what Kroszner (2006) observes to be a fundamental principle: that CCPs' governance arrangements should provide those with exposure with "substantial influence over the CCP's risk management policies".<sup>3</sup>

### 3 CENTRAL COUNTERPARTY GOODS AND OPERATING MODELS

It is natural to ask whether the current model of CCP resource provision, which evolved to provide privately owned CCPs with loss mutualization among clearing members, remains appropriate now that CCPs have grown and expanded to support a public financial stability objective. The study of different types of goods has a large literature, founded in the 1960s (Buchanan 1965; Coase 1960). In this section, these ideas are used to analyze the problem of CCP operating models in the post-Pittsburgh policy framework.

#### 3.1 CCPs and types of goods

Table 1 provides a simple classification of goods based on their rivalrous and exclusion characteristics. The nonrivalrous and nonexcludable nature of financial stability makes it a public good. On the contrary, traditional CCP services are nonrivalrous but exclusive, making them club goods.<sup>4</sup> The classification in Table 1 highlights an important characteristic of the post-Pittsburgh world; that is, expanding the role of central clearing through CCPs in pursuit of financial stability offers a club solution to a public goods problem.

The exclusive character of CCP services is at odds with the nonexclusive nature of financial stability. This could lead to misaligned incentives between those benefiting from financial stability and those bearing the cost to deliver such benefits. If CCPs are properly managed, then all market participants benefit from the stability they foster. Related markets and a broad range of stakeholders, including those that do not directly participate in derivatives or even financial markets, benefit too. This is in

---

that hedge exposures held outside of the CCP. Indeed, a client with directional exposures and a contingent obligation under VMGH might enjoy few direct benefits from central clearing, since it would have limited scope for netting, while bearing a disproportionate cost of "insuring" the CCP in times of stress.

<sup>3</sup> More generally, Kroszner (2006, p. 38) notes that, in the traditional mutualized clearing model, members have incentives "to support the imposition of risk controls that limit the extent to which the trading activities of any individual member expose all other members to losses". Importantly, he emphasizes that the effectiveness of such arrangements rests on "the ability to act on such incentives".

<sup>4</sup> The nonrivalrous nature of traditional CCP services comes from the fact that, operationally, the marginal cost of clearing an additional trade is very low, and in cases where trades reduce risk in the cleared portfolio, the marginal cost could be negative.

**TABLE 1** Classification of goods.

	<b>Excludable</b> Only paying participants can have access to the good	<b>Nonexcludable</b> Nonpaying market participants can have access to the good
<b>Rivalrous</b> Consumption by one consumer prevents simultaneous consumption by other consumers	Private goods	Common-pool goods
<b>Nonrivalrous</b> Consumption by one consumer does not prevent simultaneous consumption by other consumers; marginal cost of production is zero	Club goods	Public goods

part due to the efficient allocation of social resources that accompanies a stable and well-functioning financial sector.

Having said that, risk management is costly for CCPs, so they may have an incentive to underinvest in it. As a consequence, they may restrict the public benefits of financial stability. Huang (2016) shows how this can arise in some situations where CCPs compete. In such cases, a CCP may have an incentive to reduce the resources in its default waterfall in order to remain competitive. To prevent this “race to the bottom” in risk management practices, regulators have imposed minimum standards for the management of CCPs (eg, CPMI–IOSCO 2012). However, current regulatory and supervisory practices do not completely alleviate the initial tension between the exclusive nature of CCP services and the public benefits of financial stability. Therefore, considering alternative operating models for central clearing could help us devise incentive-compatible strategies for achieving sustainable levels of financial stability that approximate the social optimum.

### 3.2 Alternative CCP operating models

Many CCPs are now privately owned and feature a mutualized (club-like) loss allocation to their members. As noted above, this model creates tensions between the rights of and risks borne by shareholders and those of members (Huang 2016; Lewis and McPartland 2017). It may also affect ease of access to clearing, as discussed in CGFS (2011). However, this model is not the only way that CCPs can be organized. In this subsection, we introduce alternative stylized operating models and compare these with the usual model.



The tension between gains going to private shareholders but losses being mutualized is mitigated if CCPs are owned jointly by their clearing members. In these cases, all managerial decisions as well as profits and losses related to the CCP are distributed across clearing members in proportion to their equity interests. Other models are possible too, such as a purely public CCP. To illustrate the characteristics of different CCP models more explicitly, we examine the following three “edge cases”, which reflect competing ideas on how a CCP could be organized:

- the CCP as a club for and owned by its clearing members, providing services to those who wish to join and who meet the membership criteria;
- the CCP as a public utility; and
- the CCP as a privately owned and managed financial services company.

When extreme examples of each of these models are considered, the models’ advantages and disadvantages become apparent.

### *3.2.1 The CCP as a club for members*

The club model is closest to CCPs in the pre-Pittsburgh era. Here, a group of market participants came together for three main reasons:

- to reduce their individual risks to each other through novation of trades to the CCP and multilateral netting;
- to centralize the provision of functions they would otherwise have to provide individually, such as portfolio valuation, margin calculation and default management; and
- to provide insurance to one another via the mutualization of tail losses.

Importantly, all three of these reasons relate to the pursuit of private, as opposed to public, benefits, even if the ultimate outcome delivers positive externalities including efficiency and greater financial stability.<sup>5</sup>

Membership of a club CCP is clearly voluntary, but once clearing members have joined they have to adhere to the club’s rules. However, because the CCP is a creature of its members, these rules are set jointly. In this model, the CCP can experience

---

<sup>5</sup> For example, the reduction in counterparty credit risk in cleared markets leads to higher trading volumes and more efficient price discovery, as does the product standardization that typically accompanies clearing. Similarly, CCP margin requirements and default management, among other features, enhance the public good of financial stability.

stress for various reasons, for instance, if its members do not perform on their obligations. Indeed, there are several examples of CCPs organized on broadly this basis that have experienced stress.<sup>6</sup>

One advantage of the club model is that the risks of the CCP clearly arise from the members collectively, and hence it is the responsibility of the members alone to manage them. As the CCP is a private arrangement, its rules are enforced contractually through the rule book and private law. Moreover, clubs can compete. There is no reason not to permit multiple clubs serving broadly the same interests, perhaps with overlapping membership.

The primary disadvantage of the club metaphor is that it becomes strained once membership of a CCP becomes compulsory or very highly incentivized. This is now the case, given the regulations requiring market participants to clear standardized OTC derivatives as well as the capital and margin requirements that incentivize the clearing of nonmandatory derivatives. It then becomes harder to say: “If you don’t like the club’s rules, don’t join.”<sup>7</sup>

In fact, since economies of scale and network externalities tend to drive the market structure to one or a few CCPs per asset class (Duffie and Zhu 2011; Padoa-Schioppa 2007), participants generally have little choice as to which club’s rules they sign up to, whether directly as clearing members or indirectly as clients.<sup>8</sup> The leading CCPs will clearly be systemically important and, hence, require highly robust loss allocation and recovery and resolution arrangements that can credibly address the question of how to preserve financial stability when the resources available to absorb losses have been fully or nearly exhausted.<sup>9</sup> This in turn challenges the “members’-risk, members’-responsibility” model that is central to the club CCP concept.

---

<sup>6</sup> See, for instance, Budding *et al* (2016) for an account of the stress of a New Zealand clearing house, Cox (2015) for one in Hong Kong, and Bignon and Vuillemeys (2016) for one in France. Even though some of these clearing houses did not fully conform to the modern club model, they illustrate how the failure of one or more clearing members can lead to financial distress in a CCP.

<sup>7</sup> An alternative may be to access a CCP indirectly via a client clearing provider. However, in part due to the increased capital and collateral costs of clearing, this is not necessarily attractive either.

<sup>8</sup> See BCBS–CPMI–FSB–IOSCO (2017a), Domanski *et al* (2015) and Manning and Hughes (2016) for a discussion of CCP concentration. It should also be noted here that capital and margin regulation provide strong incentives for dealers to be clearing members; so, while membership of the leading CCPs is not required by regulation, it is strongly encouraged.

<sup>9</sup> See, for instance, FSB (2017) and CPMI–IOSCO (2017b) for recent international policy thinking on the recovery and resolution of CCPs.

### 3.2.2 *The CCP as a public utility*

In the purely public model, a CCP is seen as a utility, like a road or railway:<sup>10</sup> a single-utility CCP is provided for systemically important products, and, to the extent that clearing is mandatory, this CCP must be used. Here, the overriding design principle is financial stability, with the CCP seen as a vital piece of (inter-)national infrastructure. The CCP in this setting could still have a substantial layer of resources funded by members in order to preserve good incentives, with far-tail risk absorption being guaranteed by the state. In exchange for this backstop, clearing fees would accrue to the state, and features would be implemented to eliminate any burden on the taxpayer other than the temporary provision of liquidity.<sup>11</sup>

A public utility CCP would operate under public law, much like any other utility. Indeed, something close to this model is already observed for CCPs in some jurisdictions as well as for certain other financial market infrastructures (FMIs) in many others.<sup>12</sup> If a public model was deemed appropriate only for highly systemically important transactions, where the benefits of access to clearing in stressed situations are greatest, a public utility CCP clearing these trades could coexist alongside private or club CCPs clearing other classes of transactions.

The disadvantages of the public utility model include the difficulty of making the systemic/nonsystemic determination before the circumstances of financial stress are known and the potential for a monopoly CCP to stifle innovation in margin calculation, collateral management or other aspects of clearing. The difficulties of setting up and funding such a public utility should also not be ignored. Finally, default management will sometimes require significant market expertise, which will likely have to come from a CCP's members. So, in this aspect of its activities, at least, such a CCP might have to operate more like a club than a utility.

### 3.2.3 *Private CCPs for private shareholders*

Our final edge case is a model of clearing with fully private, competing CCPs. Here, the advantages of competition, diversity, innovation and private capital are seen as crucial. For the private model to work, CCPs must be both substitutable and able

---

<sup>10</sup> As Tucker (2014) puts it, some areas of CCP activity are public functions even if today the CCPs that fulfil them are not part of the state. As a related matter, this means that some CCP activities fall under public rather than private law, as Braithwaite and Murphy (2017) discuss.

<sup>11</sup> For instance, the state could recoup any sums in addition to the funded and callable resources used to stabilize the CCP after losses by imposing higher transaction fees. Access to central bank deposit and lending facilities can, in some circumstances, reduce the risk of clearing. However, if access conditions differ between public utility CCPs and privately owned CCPs, the liquidity risk profiles across clearing houses may diverge.

<sup>12</sup> Most notably, the high-value payment system in many jurisdictions is owned and operated by the central bank.

to fail. There should be enough CCPs in any given product class that even if CCP resolution is necessary, clearing services can always be conducted by transferring a failing CCP's cleared contracts to a competitor.

We have already noted that there are features in central clearing that tend to produce winner-takes-all outcomes. A concentrated market structure may also be optimal from a welfare perspective. That said, a policy maker seeking to promote the innovation and user-responsiveness goals of competition may nevertheless pursue policies to encourage diversity of CCPs. These may, for instance, take the form of taxes on dominance in the provision of clearing services. However, if these policies do not work and concentrated provision persists, CCP resolution by business transfer might be impractical. In such circumstances, it may be time-inconsistent for public authorities to allow a private CCP to fail. As a result, there is still a risk that purely private CCPs might enjoy a too-difficult-to-transfer, too-big-to-fail subsidy.

### 3.2.4 Summary

The three edge-case models discussed above all have problems in the post-Pittsburgh world. To simplify a nuanced set of issues: the voluntary character of club CCPs does not fit very well with mandatory clearing; utility CCPs may fail to innovate; and the private model could lead to misaligned incentives if profits are allocated to shareholders when things go well and losses are allocated to other participants when things go badly. The conventional solution to this problem has been to blend elements of two or more models into a single CCP, for instance, having club-style governance and loss allocation but a layer of private capital. In Section 5, we discuss an alternative, splitting the CCP along functional lines. First, however, a more detailed discussion of the sources of CCP risk and their implications for CCP resource provision is necessary.

## 4 SOURCES OF RISK AND CENTRAL COUNTERPARTY RESOURCE PROVISION

In this section, we examine more closely how various risks are priced, allocated and mitigated in the current model of clearing. This will inform an assessment of whether there is an approach to CCP resource provision that might resolve observed tensions and better support the macroprudential policy objective of the Pittsburgh commitment. The next two subsections discuss losses arising in the event of member default and nondefault losses.

### 4.1 Losses in the event of member default

The cost of a clearing service is not solely a function of the associated operational costs. Rather, it also encompasses the (contingent) costs of maintaining a “matched

book”. In the event of a clearing member default, the CCP must conduct an orderly and timely closeout of the network’s exposure to the defaulted member. If the procedures to manage a default are poorly designed or implemented, or insufficient resources are available to fund the replacement of the defaulted member’s portfolio, the CCP could face unfunded losses that might propagate to other clearing members and the system more broadly.

As we have argued, although the CCP’s design choices set the parameters in which market participants make their trading – and clearing – decisions, it is the members, not the CCP, that ultimately determine the quantum of replacement-cost risk to be managed in a given clearing service. Viewed through this lens, one might argue in favor of a model for CCP financial resources that aims to internalize the potential externalities of members’ choices, either through pricing or by allocating the responsibility to fund any replacement losses and liquidity shortfalls to those that generate the risk. In either case, such an approach would imply a substantial role for the consumers of clearing services – the members – as, indeed, we observe today.

However, it is by no means straightforward to size, and therefore allocate, the CCP’s potential future exposure to replacement losses associated with the closeout process.<sup>13</sup> Considering the systemic importance of some CCPs (and the negative externalities associated with the interruption of their operations), it is often argued that such a CCP’s critical functions should continue even if the CCP is no longer financially viable. The current debate on CCP resolution heads in this direction, with the expectation often being that the CCP’s functions and obligations could be assumed by a resolution authority should the CCP’s own recovery arrangements fail to restore its viability and should the conditions for resolution be met (see FSB (2017) for details). The resolution authority may have at its disposal additional sources of funding as well as business transfer powers or the possibility to take the CCP temporarily into public ownership (eg, by establishing a bridge entity).

One way to ensure continuous provision of a CCP’s critical services would be to collateralize, in full, all potential future exposure to replacement losses. Assuming for a moment that the full potential future exposure is even measurable, to require full collateralization would almost certainly make clearing so costly that market participants would find other, probably riskier alternatives. This argues in favor of prefunding only up to a plausible expectation of such losses.

---

<sup>13</sup> Cruz Lopez *et al* (2017) argue that contributions to prefunded loss mutualization schemes (eg, default funds) in CCPs do not typically correspond to the amount of risk that market participants bring to clearing houses, suggesting a potential mispricing of the allocation of contributions. They propose a margin system that takes into account the interdependence of market participants and protects the CCP from multiple defaults. This system also acts as a Pigovian tax that increases the collateral contributions of members that bring more homogeneous risk to the CCP.

The traditional solution, as discussed earlier in this paper, has been to require defaulter-pays collateralization (in the form of initial margin) up to a given level of confidence, to mutualize losses through prefunded resources up to an extreme but plausible level, and beyond that point to rely on unfunded loss allocation. This approach increases the potential pool of resources available to deal with a default. It also creates good incentives for clearing members to take an active role in the risk governance of the CCP and monitor the credit quality of their peers.

Can the arguments in favor of mutualization justify uncapped loss allocation to members, such as is sometimes observed in CCPs' resourcing arrangements beyond the prefunded "waterfall"?<sup>14</sup> Arguably not. First, uncapped mutualization might create moral hazard problems. Second, beyond some (likely very high) level, allocation of losses to members (who themselves may be in stress) would probably itself generate negative systemic externalities. And if extreme losses are to be imposed without bound on survivors, this would surely call into question the market's confidence in a CCP's continued ability to provide a replacement-cost guarantee.

The need to preserve good incentives implies that members should bear the cost of managing the tail risk associated with the trades they bring to the CCP; each member would pay in proportion to their contribution to such risk.<sup>15</sup> However, there may be no socially optimal solution that involves the full allocation of unfunded tail risk to members. Instead, very large losses may have to be addressed by a means other than an immediate call on members if the systemic externalities of the call would be too great.

Given this, it may not be credible for the state to rely on CCPs' pre-agreed loss allocation to members in recovery. Indeed, once we clearly frame financial stability as a public good, an argument could potentially be made for some form of public support for the CCP, or, at least, temporary public funding beyond a far tail systemic threshold, if this is in the public interest, and with an *ex post* clawback provision that allows for the recovery of public funds.<sup>16</sup>

A key consideration here is how such a systemic threshold should be determined. Incentive considerations suggest that public support should be relied upon only for

---

<sup>14</sup> The PFMI require that FMIs' recovery plans be comprehensive (CPMI-IOSCO 2017b). A typical "end-of-waterfall" structure for a CCP comprises a layer of unfunded contributions from members, the haircutting of variation margin (often for a defined period, or up to a cap) and, as a last resort, the "tear-up" of cleared contracts (CPMI-IOSCO 2016).

<sup>15</sup> To the extent that members bear the tail risk, the clearing fee should be set in such a way as to ensure the CCP does not earn a profit from risks that it does not bear. It is also important that the CCP makes some contribution to the waterfall to preserve good incentives for the CCP to manage risk (see Carter and Garner 2016). If the CCP makes a material contribution to the waterfall, the cost of committing these funds would be expected to be passed on to the members.

<sup>16</sup> As Singh (2014) discusses, CCPs tend to jump to stress rather than (as banks often do) descend slowly into it. This makes intervention well before the point of nonviability much more difficult.

truly catastrophic losses, subject, of course, to the financial stability (public good) benefits outweighing the costs of providing such support in crisis.<sup>17</sup>

Another important question is from whom funds could be clawed back ex post. In principle, clawback could occur via a special levy on prevailing clearing members, on all entities served by the CCP (including members' clients), or on the financial industry more broadly. A case could be made for any one of these approaches.

Ultimately, whether they are providing a temporary or permanent funding backstop, the benefit provided by taxpayers should be properly compensated so that taxpayers enjoy a revenue stream in exchange for any far tail insurance that they are providing. This would be similar to obtaining a premium for providing insurance.<sup>18</sup>

## 4.2 Nondefault losses

Regulatory and market pressures have led CCPs to develop sophisticated practices to manage the default of individual clearing members. Meanwhile, the management of nondefault losses (NDLs) has received less attention from both regulators and industry participants. This is despite the fact that the PFMI establish standards for the management of NDLs, with specific principles for legal, business, investment, custody and operational risks.

Table 2 provides a framework to identify and classify NDL exposures based on their risk sources. At a high level, NDL exposures can be divided into those that arise directly from clearing and settlement activities, including those that entail interactions with other sectors of the financial system (eg, other FMIs, custodians, investment counterparties and settlement banks), and those that arise from operational systems or strategic business decisions. The exposures are ultimately determined by the investments the CCP makes or the contingency arrangements it establishes to manage relevant sources of risk.

Several challenges need to be addressed when developing a comprehensive framework for managing NDLs. These include the problems of identifying the stakeholders responsible for the actions that lead to a loss exposure, allocating responsibility for losses and creating good incentives.

---

<sup>17</sup> The argument is no different than that for any other public good. Take, for example, a public road. This would be funded by users' motor vehicle licences up to a reasonable estimate of the ongoing cost of maintenance and servicing. However, if a natural disaster occurred that washed away the road, it would be reasonable to expect the taxpayer to fund the repair costs at least in the short term, perhaps recouped by a special levy on motorists over a period of time.

<sup>18</sup> The usual objection to a public backstop is moral hazard. However, this is significantly mitigated if the backstop is far in the tail of the loss distribution, subject to a public interest test with the associated constructive ambiguity, properly priced ex ante, and subject to clawback ex post. It would also be expected that the state's potential future exposure was mitigated by ongoing rigorous supervision.

**TABLE 2** Risk sources of nondefault losses in CCPs.

Risk type	Definition/subtype	Illustrative examples
Investment and custody risk	Market risk: potential decrease in the value of investments funded with cash margins that leads to uncovered exposures	<ul style="list-style-type: none"> <li>• Interest rate risk on purchased bonds</li> <li>• Default risk on bond issuers</li> </ul>
	Credit risk: potential loss of margin funds due to the default of an investment counterparty or the failure of a settlement bank or FMI	<ul style="list-style-type: none"> <li>• Default of a commercial bank providing deposits to the CCP</li> <li>• Default of a repurchase agreement counterparty</li> <li>• Failure of a custodian</li> <li>• Failure or losses caused by disruptions in payment systems</li> </ul>
	Liquidity risk: potential delay or excessive cost in accessing sufficient liquidity to honor the CCP's obligations	<ul style="list-style-type: none"> <li>• Failure to make required margin payments</li> <li>• Insufficient liquidity available to conduct timely default management</li> </ul>
Business, operational and strategic risk	Legal risk: potential losses arising from the inability to enforce institutional rules or failure to comply with statutory or regulatory obligations	<ul style="list-style-type: none"> <li>• Unenforceability or illegality of rule book or other contractual provisions</li> <li>• Conflict of law across jurisdictions</li> <li>• Failure to meet legally required standards of action or decision making</li> </ul>
	Technology/cyber risk: potential losses arising from failures of information technology systems	<ul style="list-style-type: none"> <li>• Unavailability of communications systems</li> <li>• Compromise of integrity or confidentiality</li> <li>• Theft of data</li> </ul>
	Other risks	<ul style="list-style-type: none"> <li>• Fraud risk</li> <li>• Business risk</li> </ul>

In terms of stakeholder responsibility, some NDL exposures, such as the legal risk arising from the rule book, are fully within the control of the CCP. Therefore, an argument could be made that the CCP should absorb the losses derived from



such exposures. However, there are other exposures that the CCP can influence only partially. Take investment risks, for example. These are determined by the interaction of a CCP's margin and investment policies and clearing members' trading activity, including their decisions to pledge certain assets as collateral. Essentially, the CCP sets its policies for managing investment risks, given a set of external constraints (eg. access to central bank facilities, payment systems and custodians), but clearing members determine the assets posted. If clearing members pledge cash to the CCP, this must be invested. Unless the CCP has a central bank account, this investment involves market, credit and liquidity risks. Similarly, when clearing members pledge securities, the CCP restricts the set of acceptable securities and custodians in a way that influences, but does not fully determine, its residual exposures.

Despite the limited control a CCP has over its investment risk, most CCPs do not put contributions to margin and default funds at risk from NDLs. Instead, to partially manage this NDL risk, many CCPs have established arrangements whereby, beyond a specified threshold, any investment losses arising would be allocated to members or offset with CCP capital. However, NDLs can be broader than investment losses, and CCP capital is often relatively small. The occurrence of a large NDL could therefore erode the capital of a CCP and trigger its failure, even if its cleared book remains balanced (LCH 2016). Given this, in the post-Pittsburgh era of mandated central clearing, perhaps we should consider more broadly CCPs' arrangements for assigning NDLs beyond capital. These arrangements should balance the viability of CCPs with their macroprudential role of managing the public good of financial stability.<sup>19</sup>

In particular, the public-goods nature of some NDL exposures could inherently lead to systematic underinvestment of resources. In other cases, achieving adequate coverage might lead to costs that are too high for any given CCP to absorb or for clearing to remain economically feasible.

Consider, for example, cyber risk. The stability and resilience of information technology networks is a public good, particularly as the scale of such networks increases (see Table 1). If a CCP invests to keep its networks safe from cyber attacks beyond the standards of its competitors, every other CCP benefits from "herd immunity" and from having the option to adopt management solutions at a fraction of the cost (eg, by avoiding research and development costs). In addition, unlike other operational risks, cyber risk has a predatory nature in the sense that hackers aim at eroding risk management systems and constantly innovate to defeat the latest and most sophisticated defences. As a consequence, even if a CCP were to adopt the best cyber risk management practices at any given time, it is possible that it could suffer a cyber

---

<sup>19</sup> Lewis and McPartland (2017) propose a comprehensive framework for assessing NDLs, allocating them between the CCP and its members, and integrating them into the default waterfall.

attack in the future. In such circumstances, every CCP might not invest sufficiently and continuously in cyber risk management.

Therefore, just as we argued in Section 4.1 that there could be a case for some form of public support for a CCP in the event of default losses beyond a threshold, an argument could perhaps be made for some form of public sector role in addressing certain NDLS that are large enough to threaten the survival of a systemic CCP. Public sector involvement could be further restricted to cases where the private management of the associated risks could render clearing uneconomical.<sup>20</sup>

## 5 A FUNCTIONAL ANALYSIS OF CENTRAL CLEARING

The foregoing discussion has exposed a number of issues with the model of CCP resource provision in the post-Pittsburgh world, which at their heart arise from the pursuit of a public objective with a model designed for a club service. In our discussion, we have identified a number of areas where some public sector involvement might be appropriate. However, as observed in Section 3, organizing central clearing entirely as a public utility might have a number of drawbacks, including in the areas of innovation and incentives. Ultimately, it would be undesirable to introduce a bigger role for the public sector than is strictly necessary to effectively deliver the public good of financial stability.

To better tailor the ownership and operating model to the nature of the service to be provided, it is instructive to analyze the various functions that a CCP performs. A typical CCP has the following functions.<sup>21</sup>

- (1) It calculates collateral haircuts and initial margin and default fund requirements.
- (2) It provides an interface to market participants and services cleared portfolios, providing portfolio and collateral valuations, matching services, portfolio compression, etc.
- (3) It closes out the portfolios of defaulters.
- (4) It is a counterparty to cleared trades.
- (5) It has control over the custody of margin and reinvests cash collateral.

---

<sup>20</sup> Also, as discussed in Section 4.1, this public sector role does not necessarily require taxpayers to underwrite far tail NDLS. It could instead involve liquidity support to the CCP until the latter had recouped its losses from members and/or wider market participants, as in the Hong Kong Futures Exchange example discussed in Cox (2015).

<sup>21</sup> For a more detailed discussion of CCP functions, see European Association of CCP Clearing Houses (2004).

These functions are very different in their character and systemic implications. In this section, we look at how to group these functions according to whether they are most effectively provided by a model with a private, club or public orientation.<sup>22</sup>

*Functions with a private orientation.* Function (1) is the area in central clearing where competition and innovation are most salient. Advances in margin calculation, stress testing/default fund sizing, trade management and management of member collateral are important, subject to appropriate regulation.<sup>23</sup> Moreover, clients and clearing members may have different preferences and opportunity costs in this area of CCP operations, with clients sometimes preferring lower initial margin and more mutualization, and clearing members the reverse. A diversity of providers with different offerings could meet the diverse needs of the market.

*Functions with a club orientation.* In contrast, functions (2) and perhaps (3) have more of a club orientation. Function (2) involves cooperation between firms, the development of common standards and the use of industry consensus methodologies. Operational risk resulting from function (2) can reasonably be mutualized. Function (3), at least for OTC derivatives, is typically met using a default management group composed of industry secondees, so it also suits a club-style approach.

*Functions with a public orientation.* The systemic consequences of the failure of a CCP are most significant insofar as they relate to functions (4) and (5). If the CCP in a cleared market was unable to meet its obligations on margin or cleared trades, market disruption would be inevitable. Moreover, some of the largest potential NDIs are those that arise from losses on reinvested cash collateral in the absence of access to central bank facilities, so here, too, neither club nor private approaches would seem to be optimal.

The separation proposed above suggests that the different functions of a CCP could be carried out under different operational and organizational frameworks. One possible structure, for instance, might be to explicitly back extreme tail risk on a common netting set by an industry fund and/or the state's ability to levy taxes on future transactions (see also Lubben 2014 and Tucker 2014). Privately owned and operated margin and default fund calculators could then compete for fixed-term licences to

---

<sup>22</sup> Both Pirrong (2010) and Murphy (2013) discuss various splits of CCP functions; Pirrong (2010, p. 31), for instance, notes that “there is no logic that says that those functions have to be bundled”.

<sup>23</sup> Better margin modeling or collateral management can provide greater efficiency in the derivatives system: regulation should ensure that advances here are not at the expense of systemic resilience, and this could be reinforced by requiring that margin calculators commit their own capital to the default waterfall immediately after the margin they have calculated, much like current CCP “skin in the game”.

operate on the common netting set subject to regulatory standards, much as train-operating companies bid for licences to operate services on state-owned track in some countries.<sup>24</sup> The natural monopoly of providing portfolio services could then be met by an industry-owned utility operated on a club basis.

One advantage of this structure is that the privately owned components could be allowed to fail more easily if their failure did not lead to the tear-up of positions or to the inability to access clearing services. Thus, resolution may well not be necessary for the private elements. Moreover, the most systemically important functions would be explicitly backstopped, thus reducing the systemic risk that arises from the uncertain prospects of counterparties, including those who own and manage collateral.

## 6 CONCLUDING REMARKS

This paper has examined emerging tensions in the post-Pittsburgh model of CCP clearing. We have suggested that these arise from the fact that CCPs have, in essence, been adopted as a macroprudential tool to pursue the public good of financial stability. With this observation as the starting point, we have considered whether the new order has so fundamentally altered the nature of the good which CCPs provide that the traditional club operating model is no longer fit for purpose.

In particular, we have suggested that – *in extremis* – there may be a case for some form of public backstop to the capped resources provided by the immediate club of members. There may also be a case for public involvement in the management of exposures to certain types of nondefault losses, such as those arising from a cyber threat, where the private management of the associated risks could render clearing uneconomical, or where the public-goods nature of the associated risks could lead to systematic underinvestment. For far tail losses, whether caused by default or nondefault risk, public support could take the form of temporary funding to the CCP. Some form of clawback, whether from the CCP or the market more broadly, is suggested, and in any case taxpayers should be compensated for the far-tail insurance benefit they may provide.

---

<sup>24</sup> An interesting question that arises with regard to the design of a CCP with multiple margin calculators using the same netting set is how to allocate default losses between the waterfalls associated with each margin calculator. One approach might be to treat each margin calculator as a silo; therefore, losses fall where they arise, depending on the portfolio under each calculator. A variant of this would have losses entering other calculators' default funds only if the affected calculator's default fund was exhausted. However, a more efficient approach would be to allow some pooling according to a more or less granular definition of products. In this way, any excess margin on the defaulter's portfolio under one margin calculator for a given product could be used to offset losses on the defaulter's portfolio under another calculator for the same product. The allocation of losses under such a model would ultimately be weighted toward the least conservative margin calculator.

That said, we have fallen far short of suggesting that CCPs should be operated as public utilities. Rather, as a straw man to advance the debate, we have considered whether it might be feasible to decompose the CCP's functions into discrete elements and tailor the operational and organizational framework to the particular characteristics of each. Under such an approach, it may be possible to isolate the functions that are truly critical to the provision of the public good – multilateral netting of novated trades, custody of margin and reinvestment of cash collateral – and establish an explicit public backstop for these, while allowing other functions to be provided under models with either a private or a club orientation.

## DECLARATION OF INTEREST

Work on this paper began in 2017, when both Fernando Cerezetti and Mark Manning worked in the Financial Market Infrastructures Directorate at the Bank of England. The views expressed in this paper are those of the authors alone and do not reflect those of the Bank of England, the Bank of Canada, the Financial Conduct Authority or ICE Clear Europe.

## ACKNOWLEDGEMENTS

The authors' thanks are due to James Chapman, Robert Cox, Christophe Diederer, Darrell Duffie, Francisco Rivadeneyra, Peter Sneyers and Haoxiang Zhu.

## REFERENCES

- Basel Committee on Banking Supervision–Committee on Payments and Market Infrastructures–Financial Stability Board–International Organization of Securities Commissions (BCBS–CPMI–FSB–IOSCO) (2017a). Analysis of central clearing interdependencies. Report. URL: <https://bit.ly/2I5ZbVQ>.
- Basel Committee on Banking Supervision–Committee on Payments and Market Infrastructures–Financial Stability Board–International Organization of Securities Commissions (BCBS–CPMI–FSB–IOSCO) (2017b). Chairs' report on the implementation of the joint workplan for strengthening the resilience, recovery and resolvability of central counterparties. Report. URL: <https://bit.ly/2GCmZy6>.
- Bignon, V., and Vuillemeys, G. (2016). The failure of a clearinghouse: empirical evidence. Discussion Paper 11630, Centre for Economic Policy Research (<https://doi.org/10.2139/ssrn.2862673>).
- Blackrock (2016). Response to consultative report of the Committee on Payments and Market Infrastructure and International Organization of Securities Commissions on the resilience and recovery of central counterparties. Report, October 18. URL: <https://bit.ly/2Bv3fZU>.

- Braithwaite, J., and Murphy, D. (2017). Get the balance right: private rights and public policy in the post-crisis regime for OTC derivatives. *Capital Markets Law Journal* **12**(4), 480–509 (<https://doi.org/10.1093/cmlj/kmx033>).
- Buchanan, J. (1965). An economic theory of clubs. *Economica* **32**(125), 1–14 (<https://doi.org/10.2307/2552442>).
- Budding, E., and Murphy, D. (2014). Design choices in central clearing: issues facing small advanced economies. Note AN2014/08, Reserve Bank of New Zealand Analytical Notes Series.
- Budding, E., Cox, R., and Murphy, D. (2016). Central counterparties in crisis: International Commodities Clearing House, New Zealand Futures and Options Exchange and the Stephen Francis affair. *The Journal of Financial Market Infrastructures* **4**(3), 65–92 (<https://doi.org/10.21314/JFMI.2016.054>).
- Carter, L., and Garner, M. (2016). Skin in the game: central counterparty risk controls and incentives. *The Journal of Financial Market Infrastructures* **4**(3), 39–54 (<https://doi.org/10.21314/JFMI.2016.056>).
- Coase, R. H. (1960). The problem of social cost. *Journal of Law & Economics* **3**, 1–44 (<https://doi.org/10.1086/466560>).
- Cœuré, B. (2014). The known unknowns of central clearing. Speech at the Meeting on Global Economy and the Financial System, University of Chicago Booth School of Business Initiative on Global Markets, Coral Gables, March 29, European Central Bank.
- Cœuré, B. (2015). Ensuring an adequate loss-absorbing capacity of central counterparties. Remarks at Federal Reserve Bank of Chicago 2015 Symposium on Central Clearing, Chicago, IL, April 10, European Central Bank. URL: <https://bit.ly/217pjL1>.
- Cœuré, B. (2017). Central clearing: reaping the benefits, controlling the risks. *Banque de France Financial Stability Review* **21**, 97–110.
- Committee on Payment and Settlement Systems–Technical Committee of the International Organization of Securities Commissions (CPMI–IOSCO) (2012). Principles for financial market infrastructures. Report, Bank for International Settlements. URL: <http://bit.ly/1mcqA8x>.
- Committee on Payments and Market Infrastructures–International Organization of Securities Commissions (CPMI–IOSCO) (2016). Implementation monitoring of PFMI: level 3 assessment. Report on the financial risk management and recovery practices of 10 derivatives CCPs. Report, Bank for International Settlements. URL: <https://bit.ly/2TEaWnK>.
- Committee on Payments and Market Infrastructures–International Organization of Securities Commissions (CPMI–IOSCO) (2017a). Resilience of central counterparties (CCPs): further guidance on the PFMI. Report, Bank for International Settlements. URL: <https://bit.ly/2xKPGlr>.
- Committee on Payments and Market Infrastructures–International Organization of Securities Commissions (CPMI–IOSCO) (2017b). Recovery of Financial Market Infrastructures. Report, Bank for International Settlements. URL: <https://bit.ly/2WW72IX>.
- Committee on Payments and Market Infrastructures–International Organization of Securities Commissions (CPMI–IOSCO) (2017c). Implementation monitoring of PFMI: fourth update to level 1 assessment report. Report, Bank for International Settlements. URL: [www.bis.org/cpmi/publ/d166.htm](http://www.bis.org/cpmi/publ/d166.htm).

- Committee on the Global Financial System (CGFS) (2011). The macrofinancial implications of alternative configurations for access to central counterparties in OTC derivatives markets. Working Paper 46. URL: <https://bit.ly/2thlqN6>.
- Cox, R. (2015). Central counterparties in crisis: the Hong Kong Futures Exchange in the crash of 1987. *The Journal of Financial Market Infrastructures* 4(2), 73–98 (<https://doi.org/10.21314/JFMI.2015.049>).
- Cox, R., and Steigerwald, R. (2016). “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), 25–38 (<https://doi.org/10.21314/JFMI.2016.057>).
- Cruz Lopez, J. (2016). Mind the gap: undercollateralization in the global and Canadian OTCD markets. In *Analysing the Economics of Financial Market Infrastructures*, Diehl, M., Alexandrova-Kabadjova, B., Heuver, R., and Martínez-Jaramillo, S. (eds). IGI Global (<https://doi.org/10.4018/978-1-4666-8745-5.ch015>).
- Cruz Lopez, J., Harris, J., Hurlin, C., and Pérignon, C. (2017). CoMargin. *Journal of Financial and Quantitative Analysis* 52(5), 2183–2215 (<https://doi.org/10.1017/S0022109017000709>).
- Domanski, D., Gambacorta, L., and Picillo, C. (2015). Central clearing: trends and current issues. *BIS Quarterly Review*, December, 59–76.
- Duffie, D., and Zhu, H. (2011). Does a central counterparty reduce counterparty risk? *Review of Asset Pricing Studies* 1(1), 74–95 (<https://doi.org/10.1093/rapstu/rar001>).
- European Association of CCP Clearing Houses (2004). Functional definition of a central counterparty clearing house (CCP). Comments of EACH on communication from the Commission to the Council and the European Parliament – clearing and settlement in the European Union – COM (2004) 312 Annex 3. ESMA. URL: [www.esma.europa.eu/file/5752](http://www.esma.europa.eu/file/5752).
- Financial Stability Board (FSB) (2017). Guidance on central counterparty resolution and resolution planning. Report. URL: <https://bit.ly/2tei7aD>.
- Financial Stability Board–Basel Committee on Banking Supervision–Committee on Payments and Market Infrastructures–International Organization of Securities Commissions (FSB–BCBS–CPMI–IOSCO) (2015). 2015 CCP workplan. Report. URL: <https://bit.ly/2wwFw9S>.
- G20 (2009). Leaders’ statement: the Pittsburgh Summit, September 24–25, 2009. Report, FSB. URL: <https://bit.ly/2IH5T6g>.
- Gregory, J. (2014). *Central Counterparties: Mandatory Central Clearing and Initial Margin Requirements for OTC Derivatives*. Wiley (<https://doi.org/10.1002/9781118891568>).
- Huang, W. (2016). Central counterparty capitalization and misaligned incentives. Working Paper, VU University Amsterdam. URL: <https://bit.ly/2SGgd0l>.
- International Swaps and Derivatives Association (ISDA) (2015). CCP default management, recovery and continuity: a proposed recovery framework. Risk Management Position Paper.
- JPMorgan Chase (2014). What is the resolution plan for CCPs? *Perspectives*, September, 1–6, JPMorgan Chase & Co., Office of Regulatory Affairs.
- JPMorgan Chase (2017). A balancing act: aligning incentives through financial resources for effective CCP resilience, recovery and resolution. Regulatory Policy Insights, May, JPMorgan Chase & Co., Office of Regulatory Affairs. URL: <https://bit.ly/2ljs5lx>.

- Kroszner, R. (2006). Central counterparty clearing: history, innovation, and regulation. *Economic Perspectives* **30**(4), 37–41. URL: <https://bit.ly/2BtK1nB>.
- LCH (2016). Recovery & resolution: a framework for CCPs. White Paper.
- Lewis, R., and McPartland, J. (2017). Non-default loss allocation at CCPs. Working Paper, Federal Reserve Bank of Chicago.
- Lubben, S. (2014). Nationalize the clearinghouses! Research Paper 2458506, Seton Hall Public Law.
- Manning, M., and Hughes, D. (2016). Central counterparties and banks: vive la difference. *The Journal of Financial Market Infrastructures* **4**(3), 1–24 (<https://doi.org/10.21314/JFMI.2016.058>).
- Moser, J. (1998). Contracting innovations and the evolution of clearing and settlement methods of futures exchanges. Working Paper WP-1998-26, Federal Reserve Bank of Chicago (<https://doi.org/10.2139/ssrn.910505>).
- Murphy, D. (2012). The systemic risks of OTC derivatives central clearing. *Journal of Risk Management in Financial Institutions* **5**(3), 319–334.
- Murphy, D. (2013). *OTC Derivatives: Bilateral Trading and Central Clearing*. Palgrave Macmillan (<https://doi.org/10.1057/9781137293862>).
- Norman, P. (2011). *The Risk Controllers: Central Counterparty Clearing in Globalised Financial Markets*. Wiley.
- Padoa-Schioppa, T. (2007). Central counterparties: the role of multilateralism and monopoly. In *The Role of Central Counterparties: Issues Related to Central Counterparty Clearing, ECB-FED Chicago Conference*. URL: <https://bit.ly/2WSsiz6>.
- Pirrong, C. (2010). The inefficiency of clearing mandates. Paper 665, Cato Institute Policy Analysis (<https://doi.org/10.2139/ssrn.1710802>).
- Pirrong, C. (2011). The economics of central clearing: theory and practice. Discussion Paper 1, ISDA.
- Pirrong, C. (2014). Nationalize the clearinghouses? *Streetwise Professor Blog*, August 17.
- Powell, J. (2014). A financial system perspective on central clearing of derivatives. Speech at the Seventeenth Annual International Banking Conference, Chicago, IL, November 6. Board of Governors of the Federal Reserve System. URL: <https://bit.ly/2BJEt8v>.
- Rundle, J. (2016). Banks and CCPs clash over non-default losses. *Risk.net*, November 24.
- Singh, M. (2014). Limiting taxpayer “puts” – an example from central counterparties. Working Paper 14/203, IMF (<https://doi.org/10.5089/9781498322423.001>).
- Tucker, P. (2011). Clearing houses as system risk managers. Remarks at the Depository Trust & Clearing Corporation, Centre for the Study of Financial Innovation Post Trade Fellowship Launch, London, June 1, Bank for International Settlements. URL: <https://bit.ly/2Dy6390>.
- Tucker, P. (2014). Regulatory reform, stability, and central banking. Report, Hutchins Center on Fiscal and Monetary Policy at Brookings Institution. URL: <https://brook.gs/2WXRR1B>.