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Split Derivatives: Inside the World's Most Misunderstood Contract

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May 2020

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I would like to thank John Armour, Luca Enriques, Simon Gleeson, Caroline Gentile, Sean Griffith, Robert Hockett, Christian Johnson, Kate Judge, Joshua Mitts, Saule Omarova, Jeffrey Rachlinski, and Richard Squire, along with the participants of workshops organized by Cornell Law School, Columbia Law School, Fordham Law School, and the University of Oxford, for their extremely helpful comments and suggestions. I would also like to acknowledge the generous financial support of the Centre for Banking and Financial Law at the National University of Singapore. All errors remain my own.

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Abstract

Derivatives are the 'bad boys' of modern finance: exciting, dangerous, and fundamentally misunderstood. These misunderstandings stem from the failure of scholars and policymakers to fully appreciate the unique legal and economic structure of derivative contracts, along with the important differences between these contracts and conventional equity and debt securities. This paper seeks to correct these misunderstandings by splitting derivative contracts open, identifying their constituent elements, and observing how these elements interact with one another. These elements include some of the world's most sophisticated state-contingent contracting, the allocation of property and decision-making rights, and relational mechanisms such as reputation and the expectation of future dealings. The resulting hybridity essentially splits every derivative into two separate contracts: one that governs under normal market conditions, another that governs under conditions of fundamental uncertainty. In good times, derivative contracts contemplate the almost automatic determination and performance of each counterparty's obligations. In bad times, these contracts include various mechanisms designed to provide counterparties with the flexibility to incorporate new information, fill contractual gaps, and promote efficient renegotiation.

The process of splitting derivative contracts open yields a number of important policy insights. First, the bundling of contract, property, decision-making rights, and relational mechanisms makes derivatives look far more like commercial loans than publicly-traded shares or bonds. The regulatory treatment of derivatives as 'securities' — and the resulting emphasis on market transparency — thus serves to distract attention from the significant prudential risks posed by the widespread use of derivatives. Second, the flexibility associated with the relational mechanisms embedded within many derivative contracts can play a useful role in promoting both institutional and broader financial stability. This has important implications in terms of the desirability of the recent push toward mandatory central clearing of derivative contracts. It also exposes the potential perils of recent proposals to use distributed ledger technology and smart contracts to execute, clear, and settle these contracts. Finally, the widespread breakdown of these relational mechanisms can be a source of financial instability. This provides a compelling rationale for authorizing central banks to act as 'dealers of last resort' during periods of fundamental uncertainty.

Keywords: derivatives, swaps, incomplete contracting, contractual governance, collateral, securities law, Dodd-Frank Act, clearinghouses, distributed ledger technology, smart contracts, dealer of last resort

JEL Classifications: D23, D81, D82, D86, G1, G18, G23

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SPLIT DERIVATIVES: INSIDE THE WORLD'S MOST MISUNDERSTOOD CONTRACT

Dan Awrey*

Yale Journal on Regulation [forthcoming]

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INTRODUCTION

Derivatives are the 'bad boys' of modern finance: exciting, dangerous, and fundamentally misunderstood.[1] Their supporters have defended them as important instruments for measuring, managing, and transferring risk, thereby enhancing both the efficiency and resilience of the financial system.[2] Their critics have labelled them

[1] As described in greater detail in Part I, the focus of this paper is on what would have historically been referred to as 'over-the-counter' (OTC) derivatives, as distinct from exchange-traded options or futures.

[2] Alan Greenspan, "Risk Transfer and Financial Stability", speech to the Federal Reserve Bank of Chicago 41st Annual Conference on Bank Structure (5 May 2005), available at https://www.federalreserve.gov/boarddocs/speeches/2005/20050505/.

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everything from "socially useless"[3], to "financial weapons of mass destruction"[4], to "the crystal meth of finance"[5]. They have been singled out by policymakers as one of the principal catalysts of the global financial crisis of 2007-2009.[6] They have even been condemned by His Holiness the Pope.[7] Indeed, in the wake of the financial crisis, it often seems like everyone who is anyone has an opinion about derivatives.

Perhaps not surprisingly, the controversy surrounding derivatives has spawned a large and growing academic literature. Important strands of this literature examine the impact of equity and credit derivatives on corporate governance[8], the special treatment of derivatives under corporate bankruptcy law[9], the economics of bilateral versus central clearing of derivative contracts[10], and the risks stemming from the opaque dealer-intermediated structure of derivatives markets.[11] There are also significant bodies of scholarship examining both the historical regulatory treatment of derivatives[12] and the fundamental reforms to the regulation of derivatives markets introduced in response to the financial crisis.[13]

Interview with Adair Turner in "How to Tame Global Finance", *Prospect Magazine* (26 August 2009), available at https://www.prospectmagazine.co.uk/magazine/how-to-tame-global-finance (referring to complex financial instruments such as credit default swaps).

[4] Warren Buffett, Chairman's Letter Accompanying the Berkshire Hathaway, Inc. 2002 Annual Report at 14, available at http://www.berkshirehathaway.com/2002ar/2002ar.pdf.

[5] Thomas Bass, "Derivatives: The Crystal Meth of Finance", *The Huffington Post Blog* (6 May 2009), available at http://www.huffingtonpost.com/thomas-a-bass/derivatives-the-crystal-m_b_195221.html. The fact that critics seem to be able to turn a more elegant phrase perhaps helps explain the public's often negative perception of derivatives.

[6] An overview of the subsequent policy response can be found in Part II.C.

[7] *See* for example, Joe Rennison, "Pope Says Credit Default Swaps are Unethical", *The Financial Times* (18 May 2018), available at https://www.ft.com/content/645ab1f0-59fb-11e8-b8b2-d6ceb45fa9d0.

[8] *See* for example, Bernard Black and Henry Hu, "The New Vote Buying: Empty Voting and Hidden (Morphable) Ownership" (2006), 79 Southern California Law Review 811; Jordan Barry, John Hatfield, and Scott Kominers, "On Derivatives Markets and Social Welfare: A Theory of Empty Voting and Hidden Ownership" (2013), 99 Virginia Law Review 1103; Ronald Masulis and Randall Thomas, "Does Private Equity Create Wealth? The Effects of Private Equity and Derivatives on Corporate Governance" (2009), 76 University of Chicago Law Review 219; Rene Stulz, "Credit Default Swaps and the Credit Crisis" (2010), 24:1 Journal of Economic Perspectives 73, and Frank Partnoy and David Skeel, "The Promise and Peril of Credit Derivatives" (2007), 75 University of Cincinnati Law Review 1019.

[9] *See* for example, Mark Roe, "The Derivatives Market's Payment Priorities as Financial Crisis Accelerator" (2011), 63 Stanford Law Review 539; Franklin Edwards and Edward Morrison, "Derivatives and the Bankruptcy Code: Why the Special Treatment?" (2005), 22 Yale Journal on Regulation 91, Stephen Lubben, "Derivatives in Bankruptcy: The Flawed Case for Special Treatment" (2009), 12 University of Pennsylvania Journal of Business Law 61, and Partnoy and Skeel (n 8).

[10] *See* for example, Darrell Duffie and Haoxiang Zhu, "Does a Central Clearing Counterparty Reduce Counterparty Credit Risk?" (2011), 1:1 The Review of Asset Pricing Studies 74; Darrell Duffie, Ada Li, and Theo Ludke, "Policy Perspectives on OTC Derivatives Markets Infrastructure" (2010), Federal Reserve Bank of New York Staff Report No. 424, and Craig Pirrong, "The Clearinghouse Cure" (2008-2009), 31 Regulation 44. *See* also Yesha Yadav, "The Problematic Case of Clearinghouses in Complex Markets" (2013), 101 Georgetown Law Journal 387.

[11] *See* for example, Dan Awrey, "The Mechanisms of Derivatives Market Efficiency" (2016), 91:5 New York University Law Review 1104; Yesha Yadav, "Insider Trading in Derivatives Markets" (2015), 103 Georgetown Law Journal 381, and Viral Acharya and Timothy Johnson, "Insider Trading in Credit Derivatives" (2007), 84:1 Journal of Financial Economics 110.

[12] *See* for example, Lynn Stout, "Why the Law Hates Speculators: Regulation and Private Ordering in the Market for OTC Derivatives" (1999), 48 Duke Law Journal 701; Frank Partnoy, "The Shifting Contours of Global Derivatives Regulation" (2001), 22 University of Pennsylvania Journal of International Economic Law 421, and Roberta Romano, "The Political Dynamics of Derivative Securities Regulation" (1997), 14 Yale Journal on Regulation 279.

[13] *See* for example, David Skeel, *The New Financial Deal: Understanding the Dodd-Frank Act and Its (Unintended) Consequences* (John Wiley & Sons, New Jersey, 2001), chapter 4; Mark Roe,

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Despite this groundswell in academic interest, scholars have thus far paid remarkably little attention to the actual contracts at the heart of derivatives markets.[14] Policymakers, meanwhile, have often been more interested in costly turf wars than understanding precisely what it is they are fighting to regulate.[15] Yet understanding what these contracts say, how they work, and how contracting parties seek to address their inevitable limitations is extremely important: especially given the fundamental differences between these contracts and the conventional equity and debt securities that dominate academic and policy debates in the fields of corporate governance, securities law, and financial regulation.[16] In order to fully understand these differences, we need to split derivatives open, identify their constituent elements, and observe how these elements interact with one another.

As we shall see, the process of splitting derivatives open exposes a far richer and more complex universe of elements than conventional academic and policy debates would otherwise have us believe (*see* Figure 1). The first element is some of the world's most sophisticated *state-contingent contracting*. These state-contingent contract terms govern each party's payment and delivery obligations, the circumstances in which they will be required to post collateral against potential future losses, and the consequences of counterparty default.[17] Under 'normal' market conditions—in *good times*—the execution of these terms relies on input variables that are easily and objectively observable.[18] These variables include the price of the underlying asset, the value of posted collateral, and the credit ratings of the counterparties.[19] In good times, the determination and performance of each counterparty's obligations under a derivative contract may thus appear highly mechanical—almost automatic.

"Clearinghouse Overconfidence" (2013), 101:6 California Law Review 1641; Dan Awrey, "Complexity, Innovation, and the Regulation of Modern Financial Markets" (2012), 2:2 Harvard Business Law Review 235; Lynn Stout "Derivatives and the Legal Origin of the 2008 Financial Crisis" (2011), 1:1 Harvard Business Law Review 1, and Sean Griffith, "Governing Systemic Risk: Towards a Governance Structure for Derivatives Clearinghouses" (2012), 61 Emory Law Journal 1153.

[14] The most notable exception being several textbooks, the majority of which are published in the United Kingdom, that describe derivatives contracts, jurisprudence, and policy; *see* for example, Simon Firth, *Derivatives: Law and Practice* (Sweet & Maxwell, Hebden Bridge, 2015); Alistair Hudson, *The Law on Financial Derivatives*, 5th ed. (Sweet & Maxwell, London, 2012). There is also an important, if relatively small, literature in the fields of anthropology and sociology that examines the operation of derivatives markets; *see* for example, Annelise Riles, *Collateral Knowledge* (Chicago University Press, Chicago, 2011) and Bruce Carruthers, "Diverging Derivatives: Law, Governance and Modern Financial Markets" (2013), 41:2 Journal of Comparative Economics 386.

[15] *See* Stout (n 12); Partnoy (n 12), and Romano (n 12) (each describing the regulatory turf wars between the Securities and Exchange Commission, Commodity Futures Trading Commission, and Federal Reserve over the regulation of derivatives).

[16] As I have described elsewhere, these differences reflect the executory nature of derivative contracts, the dealer-intermediated structure of the markets in which they trade, and the role of dealers as the primary sources of market liquidity; *see* Awrey (n 11) at 1124-1138.

[17] These state-contingent terms are described in greater detail in Parts I and II.A.

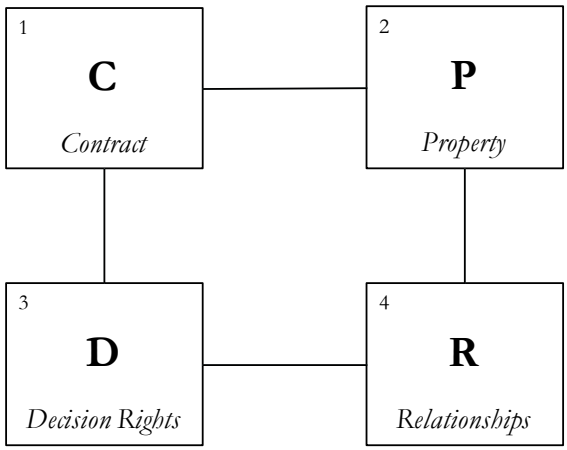
[18] For a more detailed description of these 'good times' and how the differ from 'bad' times, *see* Appendix A. One might of course ask whether normal market conditions are, in fact, 'normal' in the sense of prevailing the majority of the time. This paper brackets this question, using the term 'normal market conditions' to refer to those conditions that qualify as 'good times' as described in Appendix A.

[19] This is not to say that these input variables are *accurate*: only that they are *observable*.

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Figure 1

The Elements of a Derivative Contract



How derivatives work in good times is the product of three intertwined trends.[20] The first is the ongoing standardization of derivative contracts under the auspices of organizations such as the International Swaps and Derivatives Association (ISDA). The second—made possible by the first—is an increasing level of automation in connection with the execution, clearing, and settlement of derivative contracts. The third is the shift toward central clearing of standardized derivative contracts as mandated under the Dodd-Frank Wall Street Reform and Consumer Protection Act.[21] Together, these trends have contributed to the appearance that derivative contracts are becoming more commoditized, more transparent, and more liquid—in short, more like publicly-traded shares and bonds.

But appearances can be deceiving. For all their sophistication, the detailed state-contingent terms at the core of derivative contracts are inevitably incomplete.[22] This incompleteness reflects the high front-end costs of writing contracts that identify the entire universe of possible future states of the world and then clearly specify the rights and obligations of the counterparties in each state. It also reflects the potentially significant back-end costs of monitoring and enforcing compliance with these contracts. This incompleteness exposes counterparties to the risk that their carefully designed contracts will fail to prescribe the best possible outcomes in the states of the world that actually materialize. It also exposes them to the risk of opportunism over the life of the contract. Importantly, these risks are likely to be most pronounced during periods of fundamental uncertainty—in *bad times*—when the markets for underlying assets break down, when collateral is scarce and hard to value, and when doubts arise about the creditworthiness of the counterparties. In bad times, the determination of each

[20] The trends toward standardization, automation, and central clearing are examined in greater detail in Part II.

[21] Pub. L. 111–203, H.R. 4173 (2010) [hereinafter, the "Dodd-Frank Act"]. For the equivalent regulation in the European Union, *see* Regulation (EU) No. 648/2012 of the European Parliament and European Council on OTC Derivatives, Central Counterparties, and Trade Repositories (4 July 2012) [hereinafter, "EMIR"], available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012R0648.

[22] The sources of contractual incompleteness, the resulting risks, and the types of mechanisms that contracting parties can use to address these risks are described in greater detail in Part III.A.

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counterparty's rights and obligations can thus become highly uncertain and contested—anything but automatic.

Counterparties employ a number of formal mechanisms to address the risks posed by incomplete contracting.[23] The first mechanism is the allocation of *property rights* in the form of collateral. The requirement to post collateral can help insure parties against unexpected changes in the price of underlying assets or the creditworthiness of their counterparties.[24] It can also reduce each party's exposure to opportunism by its counterparty. The second mechanism is the allocation of *decision-making rights*. This includes the appointment of one party—known as the Valuation Agent—for the purpose of determining how much collateral counterparties are required to post. In good times, the role of the Valuation Agent is essentially administrative: simply observing market prices and other input variables and feeding them into the detailed state-contingent terms embedded within every derivative contract. In bad times, however, the Valuation Agent is called upon to use their expertise and discretion as a substitute for objectively observable information. The third mechanism is the judicious use of *broad contractual standards*. Perhaps most importantly, these standards are used to articulate a benchmark for evaluating the reasonableness of the Valuation Agent's decisions.

These formal mechanisms for addressing the risks posed by incomplete contracting are subject to several important limits. Collateral is expensive. The valuation of many financial assets is notoriously complex and subjective. The enforcement of broad contractual standards can be extremely costly and unpredictable. These limitations point to a potentially significant role for more informal mechanisms such *reputation* and *the expectation of future dealings*.[25] The threat of reputational sanctions and the loss of future revenue can incentivize counterparties to engage in cooperative problem solving and contractual renegotiation under circumstances where the rigid application of state-contingent terms is either impracticable or would lead to suboptimal outcomes. These mechanisms can also help constrain potential opportunism associated with the *ex ante* allocation of property or decision-making rights. Together with more formal mechanisms, these informal mechanisms can thus provide counterparties with the flexibility to incorporate new information, fill contractual gaps, and facilitate efficient *ex post* renegotiation. In this way, these informal mechanisms can reinforce the more formal elements of a derivative contract: incentivizing the use of detailed state-contingent terms and the allocation of property and decision-making rights in good times by providing a safety valve for modifying or relaxing the strict application of these terms in bad times.

Inevitably, these informal relational mechanisms have their own inherent limits. As a preliminary matter, the strength of these mechanisms will typically depend on a party's expected future revenue stream from a given relationship. As the economic importance of a relationship declines, so too does the probability that these mechanisms will effectively compel parties to engage in cooperative problem solving and good faith renegotiation or deter them from behaving opportunistically. For the same reason, these mechanisms are unlikely to incentivize cooperation or constrain opportunism where a party suspects that its counterparty is in the vicinity of insolvency—or where its own survival is at stake.

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[23] These formal mechanisms and their interaction are described in greater detail in Part III.B.

[24] The nature and distinction between market and counterparty credit risk is described in greater detail in Part I.

[25] These informal mechanisms and their interaction with the other elements of derivative contracts are examined in greater detail in Part III.

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The effectiveness of both reputation and the expectation of future dealings also relies on cooperative or opportunistic behaviour being easily observable. These mechanisms are thus less likely to work within widely dispersed or opaque markets, or in the presence of pronounced asymmetries of information and expertise. Along the same vein, the influence of these mechanisms is likely to be relatively modest in the absence of meaningful competition: with the number of prospective counterparties influencing the credibility of a party's threat to take its business elsewhere in response to uncooperative or opportunistic behaviour. Finally, counterparties will often face powerful countervailing incentives stemming from the use of collateral and the possibility that reputation and the expectation of future dealings may work at cross purposes. Accordingly, while these informal mechanisms can help make derivative contracts more resilient in the face of uncertainty, they do not represent a complete solution to the problems of incomplete contracting.

The process of unbundling derivatives thus reveals a complex and heterogeneous collection of different elements—a fundamentally *hybrid* financial instrument. This hybridity enables derivative contracts to morph between what economists Raghuram Rajan and Luigi Zingales have characterized as "arm's-length" and "relational" financing depending on the state of the world in which the counterparties find themselves.[26] In good times, derivative contracts trade in deep, liquid, and informationally sensitive markets. In bad times, the very same contracts can be characterized by acute information problems, paralyzing illiquidity, and the resulting dominance of relationships over markets.

Acknowledging the fundamental hybridity of derivative contracts yields a number of important policy insights. First, the braiding of contract, property, decision-making rights, and relational mechanisms makes derivatives look far more like commercial loans than publicly-traded shares or bonds. The regulatory treatment of derivatives as 'securities' under the Dodd-Frank Act—and the resulting emphasis on market transparency—thus serves to distract regulatory attention from the significant prudential risks posed by the widespread use of derivatives. Second, the flexibility associated with the relational mechanisms embedded within many derivative contracts can play a useful role in promoting both institutional and broader financial stability. This has important implications in terms of the desirability of mandatory central clearing of derivatives under the Dodd-Frank Act, where the elimination of these mechanisms may leave clearinghouses and other counterparties vulnerable to destabilizing contractual rigidity. This same rigidity risks undermining the inherent promise of recent proposals to use distributed ledger technology and smart contracts to execute, clear, and settle derivative contracts. By the same token, the widespread breakdown of these relational mechanisms can be a source of pronounced financial instability. This provides a compelling rationale for authorizing central banks to act as 'dealers of last resort' during periods of fundamental uncertainty.

The failure of scholars and policymakers to fully appreciate the hybrid nature of derivative contracts is also the source of a number of enduring misunderstandings. These misunderstandings are reflected in the widespread and erroneous belief that derivatives are zero sum bets on future price movements, that central clearing of derivatives can eliminate their attendant risks, and that derivatives are fundamentally no different from shares, bonds, or other financial instruments. Lamentably, these beliefs continue to find their way into both policy debates and the pages of leading law

[26] Raghuram Rajan and Luigi Zingales, "Which Capitalism? Lesson from the East Asian Crisis" (1998), 11:3 Journal of Applied Corporate Finance 40 (explaining the distinction between arm's-length and relational financing).

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reviews.[27] One of the objectives of this article is to correct these misunderstandings, thereby leaving us in a better position to explore the important questions raised by the widespread use of derivative contracts and the changing structure of derivatives markets.

This paper proceeds as follows. Part I describes the basic anatomy of every derivative contract: their core building blocks, the nature and importance of market and counterparty credit risk, and the mechanisms counterparties use to manage these risks. Part II describes how derivatives work in good times, and traces the intertwined trends toward standardization, automation, and central clearing within derivatives markets. Part III then describes how derivatives work in bad times. It begins by identifying the sources of incomplete contracting, the risks that it poses to contracting parties, and the range of formal and informal mechanisms that can theoretically be used to address these risks. It then examines how these mechanisms are collectively used to address the risks posed by incomplete contracting within derivatives markets. To help illuminate how these mechanisms work, how they interact with one another, and their inherent limits, this examination draws on a case study involving the renegotiation of a portfolio of credit default swaps between Goldman Sachs and AIG at the height of the financial crisis. Part IV concludes by examining some of the important policy insights that flow from the hybrid nature of derivative contracts.

I. THE ANATOMY OF A DERIVATIVE CONTRACT

There is no doubt that derivatives are complex.[28] Yet beneath all the sophisticated mathematics, impenetrable financial jargon, and dense legal documentation resides a universal economic structure: the basic anatomy of every derivative contract. This anatomy begins with the two building blocks from which all derivatives are created: options and forwards.[29] An option gives the holder a *right* to purchase or sell an asset at a predetermined price at some point in the future.[30] This right is then combined with an *obligation* on the part of the option writer to buy or sell the asset, as applicable, upon the holder's exercise of the option. A forward, meanwhile, represents a pair of reciprocal *obligations* for one party to buy an asset, and the other party to sell it, at a specified price and time.[31] These two building blocks can be combined in an infinite number of ways, in connection with virtually any underlying asset—thus theoretically making possible a nearly infinite variety of different derivative contracts.

The anatomy of a derivative contract exposes the parties to two principal risks. The first risk stems from movements in the price of an underlying asset, index, or interest rate, or the occurrence of a specified future event—often referred to simply as the 'underlying'.[32] This underlying can be an individual stock or bond, a basket of financial

[27] Some of these beliefs are examined in greater detail in Part I.

[28] For an examination of the complexity of derivatives markets, *see* Awrey (n 13) at 245-258 (describing six drivers of complexity within derivatives markets: technology, opacity, interconnectedness, fragmentation, regulation, and reflexivity).

[29] For a more detailed description of these basic building blocks and how they can be combined to create more complex derivatives, *see* Richard Flavell, *Swaps and other Derivatives*, 2nd ed. (John Wiley & Sons Ltd., Chichester, 2009).

[30] A right to purchase an asset is known as a 'call' option; a right to sell an asset is known as a 'put' option.

[31] Forwards either contemplate the actual delivery of the underlying (i.e. *physical* settlement) or a payment based on movements in the price of the underlying (i.e. *cash* settlement).

[32] Importantly, the precise relationship between movements in the price of the underlying and the resulting payoffs to the counterparties are determined *ex ante* and enshrined in contract. This serves to distinguish derivative contracts from other assets or claims—e.g. shares, bonds, or dividends—the value of which are in some sense also 'derived' from underlying assets.

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instruments, or a physical commodity. It can also be a benchmark interest rate, currency exchange rate, financial index, or other more exotic underlying. This exposure to movements in the price of the underlying is known as *market risk*. The second risk stems from the prospect that a party will not be able to perform its obligations under a derivative contract due to its default or insolvency. This exposure of one party to the creditworthiness of the other is known as *counterparty credit risk*. As we shall see, while derivatives expose the parties to a myriad of other risks, it is the allocation and management of market and counterparty credit risk that reside at the heart of every derivative contract.

In theory, the market risk associated with a derivative contract is completely independent of the resulting counterparty credit risk.[33] Indeed, the price of the underlying can fluctuate wildly without any impact on the creditworthiness of the counterparties. Conversely, significant changes in the price of the underlying can be negated by the inability of a counterparty to honour its commitments. This is a unique and important feature of derivative contracts. As residual claims on the assets of a corporation, common shares do not generate counterparty credit risk—only market risk. Bonds and other fixed income securities, meanwhile, bundle market and counterparty credit risk together—with the market price of the securities inextricably linked with the creditworthiness of the issuer.[34] Unlike conventional equity and debt securities, understanding how derivative contracts work thus demands that we draw a sharp distinction between market and counterparty credit risk.

An example may help illuminate the basic economic structure of a derivative contract, along with the important distinction between market and counterparty credit risk. One of the most common types of derivative contract is an interest rate swap.[35] A swap is a series of forwards whereby two counterparties agree to periodically exchange cash flows over a specified period of time. A 'plain vanilla' interest rate swap involves one counterparty agreeing to make payments at a fixed interest rate to another counterparty, who in turn agrees to pay a 'floating' rate typically based on a financial benchmark such as the London Interbank Offered Rate (Libor).[36] In the example in Figure 2, Counterparty A has agreed to pay a fixed rate of 5.0% every six months over a period of five years, while Counterparty B has agreed to pay a floating rate of Libor plus 2.0%. As the counterparty receiving the floating rate, Counterparty A thus stands to benefit from any subsequent increase in interest rates, whereas Counterparty B stands to benefit from any decline.

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[33] In practice, of course, the two may be correlated where, for example, the exposure under a derivative contract represents a significant proportion of a counterparty's total liabilities (where adverse price movements in the underlying could have an impact on the counterparty's solvency).

[34] This exposes the inherent conceptual misunderstanding at the heart of proposals to expand central clearing to debt instruments other than derivatives; *see* for example, Steven Schwarcz, "Central Clearing of Financial Contracts: Theory and Regulatory Implications" (2018), 167 University of Pennsylvania Law Review [forthcoming]. As described in greater detail in Part II.C, the benefits of central clearing of derivatives flow from the fact that clearinghouses concentrate counterparty credit risk, while leaving the original counterparties exposed to market risk. This is not possible in other debt markets, where market and counterparty credit risk cannot be separated (at least not without the use of a derivative!).

[35] As of 31 December 2016, interest rate forwards and swaps represented approximately 76% of the global OTC derivatives market; *see* Bank for International Settlements (BIS), Semi-annual Derivatives Statistics, Table D5, available at http://www.bis.org/statistics/derstats.htm.

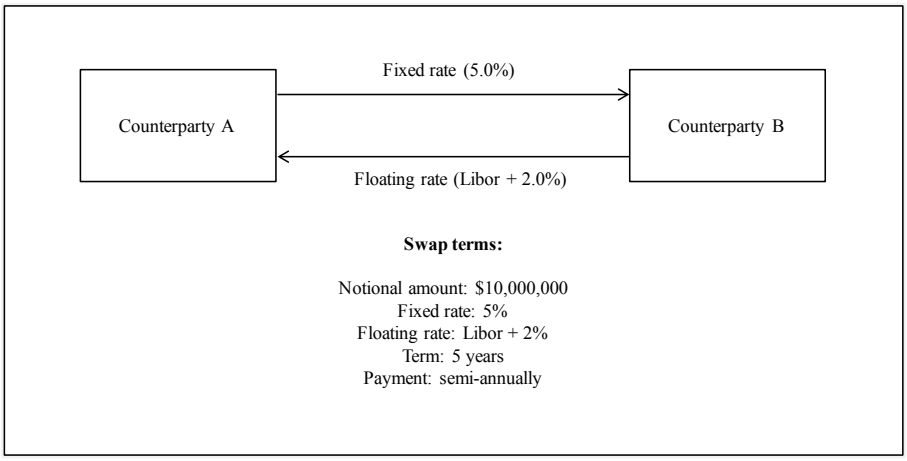
[36] As a result of several high profile scandals involving the alleged manipulation of Libor, the Bank of England has announced its plan to replace Libor with a new benchmark (SONIA) based on more reliable market data; Bank of England Press Release, "SONIA Reform to be Implemented on 23 April 2018" (16 October 2017), available at http://www.bankofengland.co.uk/publications/Pages/news/2017/060.aspx.

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The periodic payments due under a swap are calculated with reference to a 'notional amount' ($USD10,000,000 in our example). The resulting obligations are then netted out against one another so that only one counterparty is obligated to make payment on the settlement date at the end of any given six-month period. For example, where the prevailing Libor rate was 2.0% as of a particular settlement date, Counterparty B would be entitled to payment from Counterparty A in the amount of 5.0% - (Libor + 2.0%) = 1.0% x 10,000,000 = $USD100,000. The obligation to make this payment would represent the crystallization of Counterparty A's exposure to the market risk associated with upward movements in Libor. Counterparty B is then exposed to the counterparty credit risk stemming from the possibility that Counterparty A will not be able to perform its payment obligation.

Figure 2

A Plain Vanilla Interest Rate Swap



The first thing that this example makes clear is that both market and counterparty credit risk are a function of *time*. Under a typical swap contract, for example, both counterparties will owe contingent obligations toward one another over a period that may span several years.[37] It is this passage of time that exposes counterparties to price movements and introduces the risk that a counterparty may default between the moment that the contract is entered into and the full and complete performance of each counterparty's obligations. The prospect of default or insolvency, in turn, makes the creditworthiness—and thus the *identity*—of the counterparties highly relevant from a contracting perspective. Put bluntly, the contractual commitments of some counterparties will be more credible than others.

The passage of time has important implications in terms of the ongoing costs of contractual monitoring and enforcement. First, counterparties must be able to observe movements in the market price of the underlying over time.[38] Where the underlying is a publicly-traded stock or widely published financial benchmark, the costs of observing these price movements may be negligible. However, where the underlying is traded in

[37] As of December 2016, the BIS reported that over half of all interest rate and equity-linked swaps, and roughly a quarter of all foreign exchange swaps, were for durations of greater than one year; BIS, OTC Derivatives Statistics as at end-December 2016 (May 2017) at 5-7, available at https://www.bis.org.

[38] Or at the very least as of each contemplated settlement date.

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less liquid or more opaque markets, where the markets for the underlying have broken down, or where 'price' is a function of sophisticated financial modelling, these observation costs may be very significant. Along the same vein, it may be costly to observe the occurrence of events—e.g. the default of a corporation on its debt—designed to trigger payouts under a derivative contract. Second, the duration of derivative contracts, along with the corresponding exposure to counterparty credit risk, theoretically generate powerful incentives for parties to engage in *ex ante* screening of the creditworthiness of potential counterparties.[39] Thereafter, it also incentivizes them to engage in *ex post* monitoring of their counterparties over the life of a derivative contract. These investments in screening and monitoring can be very costly: especially where the counterparties are large, complex financial institutions.[40].

The second thing that our example makes clear is that derivatives are a form of debt. In our example, where Libor interest rates are above 3.0% as of any given settlement date, Counterparty B will owe Counterparty A a specified sum of money. The leverage embedded within derivative contracts is also reflected in how they are used. Thus, for example, a party might enter into a five-year total return equity swap on shares of Apple Inc. with a notional value of $USD10 million, in exchange for which it will be required to make semi-annual payments of 5.0% to its counterparty. Where the price subsequently increases, the party will be entitled to payment from its counterparty equal to the capital appreciation and any dividends on $USD10 million worth of Apple shares. Where the price falls, however, the party will be required to pay its counterparty an amount commensurate with this decline. From an economic perspective, this derivative contract is thus identical to simply *borrowing* $USD10 million at a 5.0% interest rate and then investing the proceeds in Apple shares.

The last thing that our example makes clear is that the motivation for entering into a derivative contract stems from each counterparty's desire to acquire or hedge an exposure to a particular market risk—whether it be the future direction of interest rates, share prices, or the prospect that a corporation will default on its debt. Counterparty credit risk is simply a necessary by-product: the price counterparties must pay in order to use derivatives to acquire or hedge this exposure. That counterparty credit risk is essentially a necessary evil is crucial in terms of understanding the legal and economic structure of derivative contracts: from the simplest option, forward, or swap, to the most complex structured product.

Counterparties use a variety of mechanisms to mitigate counterparty credit risk.[41] The first is *payment netting*. Where counterparties have reciprocal exposures under multiple derivative contracts, payment netting contemplates the aggregation of payment obligations across these contracts and the cancelation of any offsetting payments due in

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[39] Although, as we shall see, the collateralization of derivative contracts, along with the safe harbors for derivatives under corporate bankruptcy law, can be viewed as significantly undercutting these incentives.

[40] This intuition is supported by the empirical research of Donald Morgan, who finds an unusual pattern of disagreement—or 'splits'—between credit rating agencies over the ratings of banks and insurance firms; *see* Donald Morgan, "Rating Banks: Risk and Uncertainty in an Opaque Industry" (2002), 92:4 American Economic Review 874. Morgan attributes this disagreement to the high costs of observing the quality of these firms' assets and the nature of their trading activities; ibid. Compounding matters, because no two counterparties are identical, the idiosyncratic nature of these investments means that they are likely to be largely unrecoverable; *See* Oliver Williamson, "Transactions-Cost Economics: The Governance of Contractual Relations" (1979), 22:2 Journal of Law and Economics 233 at 239-245.

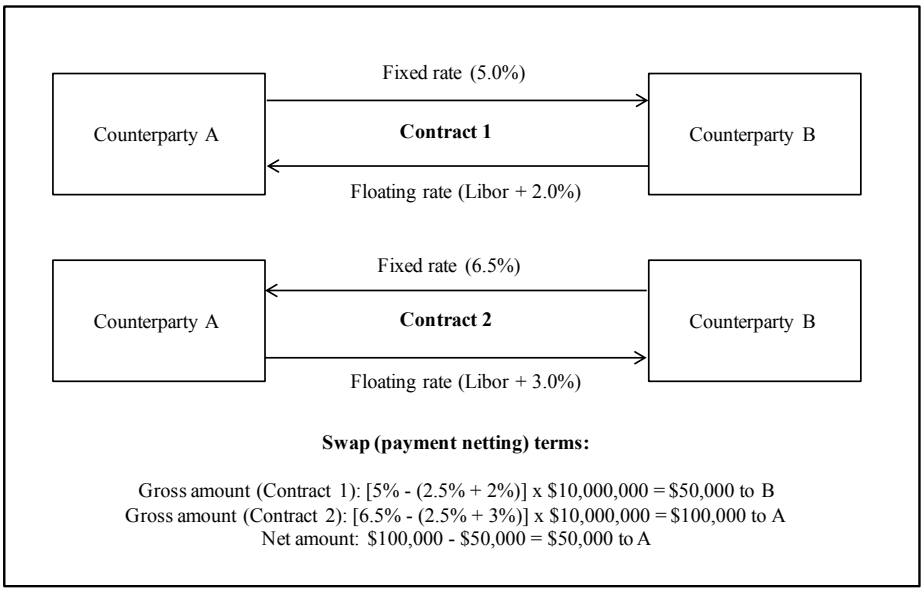
[41] *See* John Armour, Dan Awrey, Paul Davies, Luca Enriques, Jeffrey Gordon, Colin Mayer, and Jennifer Payne, *Principles of Financial Regulation* (Oxford University Press, Oxford, 2016) at 469-470. *See* also Awrey (n 11) at 1148-1152.

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the same currency and on the same settlement date. In effect, payment netting converts multiple gross payments owed by both counterparties into a single net payment owed by only one them (*see* Figure 3). By eliminating the requirement for both counterparties to exchange gross payments, payment netting thus avoids so-called 'daylight' exposures where the sequential performance of payment obligations would otherwise expose the counterparty that pays first to the risk that its counterparty will subsequently default. Perhaps more importantly, by reducing the overall number and size of payments, payment netting reduces each party's outstanding exposure in the event that its counterparty is unable to perform its payment obligations.

Figure 3

Derivatives Payment Netting



The second mechanism used to mitigate counterparty credit risk is *closeout netting*. Closeout netting involves the termination, valuation, and netting out of contractual obligations in the event of a counterparty's default or insolvency.[42] Where the netted closeout amount puts the *non-defaulting* counterparty in the money, closeout netting entitles this party to immediately seize (as necessary[43]) and liquidate any collateral posted by the defaulting counterparty in satisfaction of this amount.[44] Where the *defaulting* counterparty is in the money, closeout netting entitles the non-defaulting party to set off against the amount it owes to the defaulting counterparty any amounts

[42] For a more detailed description of the mechanics of closeout netting, *see* David Mengle, "Closeout Netting and Risk Management in Over-the-Counter Derivatives" (1 June 2010), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1619480.

[43] The precise operation of closeout netting will depend on whether the relevant collateral was posted pursuant to a title transfer or security interest system. Under a title transfer system, there is technically no need for a non-defaulting counterparty to 'seize' the relevant collateral upon default as the non-defaulting counterparty or its delegate will already be in possession of it. For further details regarding the distinction between title transfer and security interest systems, *see* Firth (n 14) at 6-7-6-15.

[44] With any residual amounts owed generally being treated as an unsecured claim against the defaulting counterparty's estate; *see* Mengle (n 42) at 3.

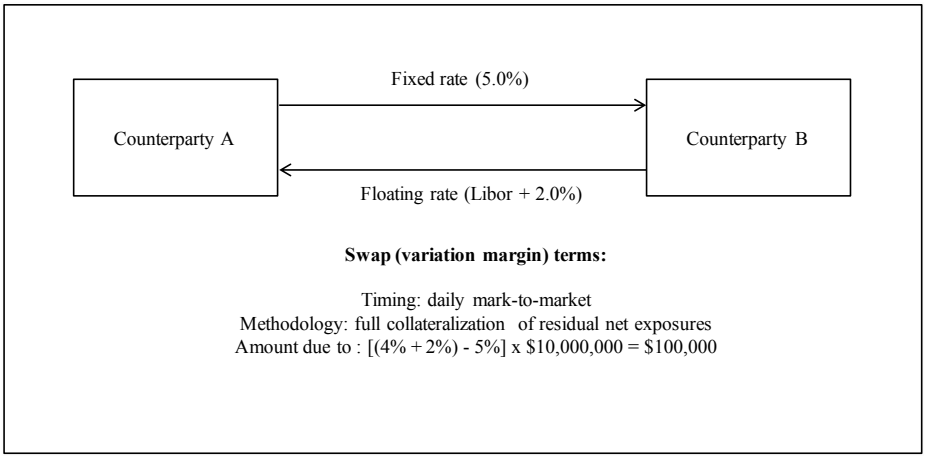
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owed to it by the defaulting counterparty.[45] Importantly, the enforceability of closeout netting relies on a series of safe harbors from the automatic stay and fraudulent preference rules under applicable corporate bankruptcy laws.[46]

The final mechanism used to mitigate counterparty credit risk is *collateral*. The parties to derivative contracts will often seek to minimize their residual net exposures after payment netting by requiring their counterparties to post collateral at the outset of the contract. This collateral, often referred to as 'initial margin', is theoretically designed to reflect each party's exposure to the default or insolvency of its counterparty over the duration of the contract. Thereafter, counterparties also periodically recalculate the amount of collateral that one or both counterparties are required to post. This 'variation margin' is designed to reflect changes in the market price of the underlying. Returning to our earlier example, in the event that Libor were to increase from 2.5% to 4.0% during the period between two settlement dates, variation margin requirements would require Counterparty B to post collateral to Counterparty A as security against its potential future payment obligations (*see* Figure 4). Like closeout netting, the enforceability of these collateral arrangements relies on safe harbors under applicable corporate bankruptcy laws.

Figure 4

Derivatives Variation Margin Requirements



In theory, payment netting, closeout netting, and collateral can eliminate a party's exposure to counterparty credit risk. Specifically, where a party is fully collateralized and can legally and instantaneously enforce closeout netting upon the default of its counterparty, these mechanisms will put the non-defaulting counterparty in essentially the same position as it would have been had its counterparty not defaulted. These mechanisms thus combine to render parties economically indifferent to the creditworthiness of their counterparties, thereby eliminating any incentive to engage in costly screening or monitoring. Viewed from this perspective, these mechanisms can

[45] This setoff is available irrespective of whether the amounts owed to the non-defaulting counterparty relate to derivatives trades or other obligations.

[46] For a detailed description of these safe harbors and the debate that surrounds them, *see* Roe (n 9); Partnoy and Skeel (n 9), and Edwards and Morrison (n 9). For further information about the equivalent safe harbors in the United Kingdom and European Union, *see* Hudson (n 14).

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be understood as substitutes for investments in evaluating counterparty credit risk, leaving the parties in what Bengt Holmstrom has characterized as a state of "symmetric ignorance" about the credibility of their counterparty's commitment to perform their payment and other obligations.[47]

In reality, these contractual mechanisms are unlikely to completely insulate parties against the risk of counterparty default or insolvency. As a preliminary matter, closeout netting and collateral do not eliminate counterparty credit risk: they simply transform it into market risk in the posted collateral. In order to fully protect counterparties, the value of this collateral must at least equal the amount owed to the non-defaulting counterparty after the application of closeout netting in each and every potential future state of the world. For this reason, the most effective types of collateral are extremely liquid and informationally insensitive debt such as cash and highly-rated sovereign debt.[48] Ideally, the value of this collateral should also not be correlated with the price of the underlying or the creditworthiness of the counterparty required to post it. While available data suggests that cash is the most frequently used form of collateral within derivative markets[49], the costs of posting cash have increased considerably in the wake of the financial crisis.[50] Where counterparties use more informationally sensitive—and hence more volatile—forms of collateral such as lower quality sovereign debt, corporate bonds, or equity securities, this will inevitably expose counterparties to the risk that they will be unable to sell the collateral at a price that fully covers their residual net exposure

[47] *See* Bengt Holmstrom, "Understanding the Role of Debt in the Financial System", BIS Working Paper No. 479 (January 2015) at 6, available at http://www.bis.org. *See* Kate Judge, "Information Gaps and Shadow Banking" (2017), 103 Virginia Law Review [forthcoming] at 12. While Holmstrom was writing in relation to money markets, his analysis also accurately describes the information cost dynamics of closeout netting and collateralization within derivatives markets.

[48] *See* Gary Gorton and Guillermo Ordonez, "Collateral Crises" (2014), 104:2 American Economic Review 343; Tri Vi Dang, Gary Gorton, Bengt Holmstrom, "Ignorance, Debt and the Financial Crisis", Working Paper (March 2013) [working paper on file with author], and Holmstrom (n 47).

[49] Respondents to ISDA's 2015 margin survey reported that 76.6% of collateral received and 77.7% of collateral delivered in connection with bilaterally cleared derivatives contracts was in the form of cash; *see* ISDA, Margin Survey (11 August 2015), available at https://www2.isda.org/functional-areas/research/surveys/margin-surveys/.

[50] The increasing cost of posting cash and other high quality liquid assets in the wake of the financial crisis is principally due to new regulatory requirements that mandate or incentivize financial institutions to hold a larger stock of these assets. These requirements include the Liquidity Coverage Ratio introduced under Basel III, new initial and variation margin requirements for derivatives, and restrictions on the reuse and rehypothecation of collateral; *see* Basel Committee on Banking Supervision (BCBS), "Liquidity Coverage Ratio (LCR)" (January 2013), available at available at http://www.bis.org/bcbs/basel3.htm; BCBS and International Organization of Securities Commissions (IOSCO), "Margin Requirements for Non-Centrally Cleared Derivatives" (March 2015), available at http://www.bis.org/publ/bcbs261.pdf; Financial Stability Board (FSB), "Strengthening Oversight and Regulation of Shadow Banking: Policy Framework for Strengthening Oversight and Regulation of Shadow Banking Entities" (29 August 2013), available at www.financialstabilityboard.org/wp-content/uploads/r_130829b.pdf?page_moved=1. and FSB, "Strengthening Oversight and Regulation of Shadow Banking: Policy Framework for Addressing Shadow Banking Risks in Securities Lending and Repos" (29 August 2013), available at www.financialstabilityboard.org/wp-content/uploads/r_130829b.pdf?page_moved=1. Many of these requirements have been incorporated into U.S. law; *see* for example, Department of the Treasury, Federal Reserve System, and Federal Deposit Insurance Corporation (FDIC), Liquidity Coverage Ratio: Liquidity Risk Measurement Standards: Final Rule, 79 Fed. Reg. 179 (10 October 2014); Department of the Treasury, Federal Reserve System, FDIC, Farm Credit Administration, and Federal Housing Finance Agency, Margin and Capital Requirements for Covered Swap Entities: Final Rule, 80 Fed. Reg. 74840 (30 November 2015), and Commodity Futures Trading Commission (CFTC), Margin Requirements for Covered Uncleared Swaps for Swap Dealers and Major Swap Participants: Final Rule, 81 Fed. Reg. 636 (6 January 2016).

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to defaulting counterparties.[51] Given the opportunity costs of posting collateral, counterparties may also rationally elect not to fully collateralize their residual net exposures.[52] Indeed, while available data is scarce, it is likely that a significant fraction of derivative contracts have historically not been fully collateralized.[53] Last but not least, non-defaulting counterparties face the risk—known as 'replacement' risk—that they will be unable to enter into an economically equivalent derivative contract with a new and more creditworthy counterparty. Where any of these risks materializes, the default or insolvency of one counterparty will leave the other counterparty in a worse position than it would have been had the defaulting counterparty continued to perform its payment and other obligations.

The high costs of screening, monitoring, and mitigating counterparty credit risk have had an important impact on the structure of derivatives markets. Derivatives markets are loosely organized around a small group of large financial institutions known colloquially as 'dealers'. Prominent derivative dealers include Citigroup, JP Morgan, Goldman Sachs, Deutsche Bank, and HSBC.[54] These dealers quote bid and asking prices to prospective counterparties on the understanding that they are willing to take either side of the contemplated contract.[55] Returning once again to our example, a dealer might quote Counterparty B a bid of 5.0% and an ask of 5.05% on the fixed leg of our plain vanilla interest rate swap. The quoted bid represents the gross interest rate that Counterparty B would receive if it were to elect to take the fixed leg of the swap, while the quoted ask represents the rate it would be required to pay if it were to take the floating leg. The dealer will then typically look to hedge its exposure by seeking out and entering into one or more offsetting swaps with other counterparties.[56] In theory at least, dealers thus attempt to profit not by placing bets on the future direction of prices, but by charging a fee—typically embedded in the spread between the quoted bid and asking prices—for their willingness to stand on the opposite side of the contract.[57] The end

[51] To address this risk, counterparties can apply a discount (or 'haircut') to the value of non-cash collateral. The size of the haircut will typically reflect the historical volatility in the price of the collateral assets; *see* Part II for a more detailed description of the contractual terms operationalizing these haircuts.

[52] As described in Part II.A, counterparties can do this by agreeing to a 'Threshold' specifying the size of the residual net exposure below which collateral will not need to be posted. They can also agree to 'Minimum Transfer Amounts' that eliminate the obligation to post collateral below a specified amount.

[53] *See* Manmohan Singh, "Under-Collateralization and Rehypothecation in the OTC Derivatives Markets", Banque de France Financial Stability Review No. 14 (July 2010), available at https://www.banque-france.fr. Singh estimates that the top five derivative dealers in each of the United States and Europe were collectively under-collateralized by as much as $USD1.2 trillion as of December 2008; ibid. at 114.

[54] The fourteen largest global derivative dealers are collectively known as the 'G14'. The G14 is comprised of Bank of America, Barclays, BNP Paribas, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, JP Morgan Chase, Morgan Stanley, Royal Bank of Scotland, Société Générale, UBS, and Wells Fargo. Commerzbank, Credit Agricole and/or Nomura Securities are sometimes added to create the 'G16' or 'G17'. More recently, large asset managers such as BlackRock have also started dealing in derivatives; *see* David McCrum and Michael Mackenzie, "BlackRock Looks to Take On Wall Street", *The Financial Times* (12 April 2012), available at http://www.ft.com.

[55] *See* Dan Awrey, "The Limits of Private Ordering Within Modern Financial Markets" (2015), 34:1 Review of Banking and Financial Law 183 at 202. These quotes can take the form of either binding or indicative (non-binding) quotes.

[56] And in many cases other dealers. As of December 2016, the BIS reported that roughly 30% of foreign exchange derivatives, 20% of equity-linked derivatives, and 5% of interest rate derivatives were entered into between two dealers; BIS (n 37) at 5-7.

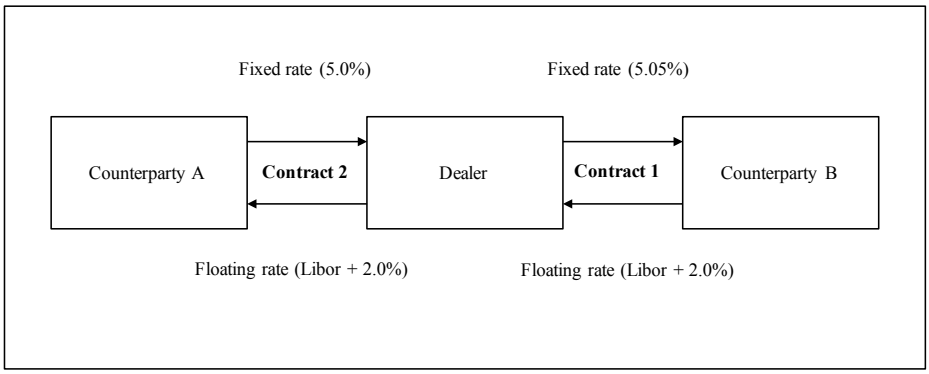
[57] *See* Darrell Duffie, "The Failure Mechanics of Dealer Banks" (2010), 24:1 Journal of Economic Perspectives 51 at 56. Where permitted by law, dealers may also enter into 'proprietary' derivatives trades on the basis of their expectations regarding the future direction of prices in the relevant underlying.

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result is two separate contracts: the first between the dealer and Counterparty B, and the second—mirroring the first—between the dealer and Counterparty A (*see* Figure 5).

Figure 5

Dealer Intermediation within Derivatives Markets



Dealers can thus be understood as performing two distinct and important roles within derivatives markets.[58] The first is to assist parties in identifying potential counterparties willing to take the opposite side of a derivative contract. Dealers are typically large commercial and investment banks whose business involves understanding their clients' business models, risk management and financing needs, and general creditworthiness. Armed with this information, dealers can then use their large client networks to identify and match counterparties whose desire to acquire or hedge an exposure to a specific underlying correspond with one another. Viewed from this perspective, dealers play a central role in the aggregation of information about the supply and demand for different derivative contracts, thereby reducing the search costs for parties looking to identify potentially suitable counterparties.

The second role relates directly to the management of counterparty credit risk. In our example, Counterparties A and B may initially possess very little information about each other. They may also be commercial firms that do not possess the financial expertise or other resources necessary to effectively screen or monitor their counterparties. These problems leave the parties extremely vulnerable to counterparty default, along with the risk of opportunism over the life of the contract. One way to manage these risks is to contractually interpose a dealer between the two counterparties. While dealers will still be exposed to the same risks, they also possess high levels of financial expertise, have large and diversified balance sheets, and enjoy access to multiple sources of market liquidity.[59] This gives dealers a comparative advantage in terms of being able to evaluate and absorb counterparty credit, market, and other risks, and to hedge any residual exposures. It also enables them to bridge any temporal gaps between the needs of any two counterparties.[60] Perhaps most importantly, the status of

[58] The nature of these roles is examined in greater detail in Awrey (n 11) at 1139-1146.

[59] Market liquidity in this context refers to the ease with which a party is able to enter into a derivative contract acquiring or hedging a particular exposure. It is typically measured on the basis of time and cost. For a general discussion of market liquidity, *see* Markus Brunnermeier and Lasse Pedersen, "Market Liquidity and Funding Liquidity" (2009), 22:6 Review of Financial Studies 2001.

[60] In this way, dealers help overcome the classic 'double coincidence of wants' problem that we might otherwise expect to observe within derivatives markets—especially with respect to more specialized or bespoke contracts. For the classic formulation of this problem, *see* William Jevons, *Money and the*

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dealers as repeat players within derivatives markets can impose reputational constraints that make them less likely to engage in opportunistic behaviour. As we shall see, this enables dealers to play an important role as reputational intermediaries: pledging their reputations to counterparties as a means of reducing information, agency, and other costs, and thereby strengthening the credibility of the commitments underpinning derivative contracts.[61]

The concentrated structure of derivatives markets has enabled dealers to exert enormous influence over both the structure and substantive content of derivative contracts, along with the legislative regimes supporting the enforceability of payment netting, closeout netting, and collateral arrangements. Over time, this has resulted in the development of highly sophisticated state-contingent contracts designed to allocate and manage market, counterparty credit, and other risks. In the next section, we examine these contracts in greater detail. We also examine the historical drive toward the standardization of derivative contracts, along with the more recent trends toward automation and central clearing within derivatives markets.

II. DERIVATIVES IN GOOD TIMES

The basic anatomy of a derivative contract is embodied within a legal architecture that includes some of the world's most sophisticated state-contingent contracting.[62] Distilled to its essence, a state-contingent contract is one that identifies a potential future state of the world and then prescribes the rights and obligations of the contracting parties in that state.[63] State-contingent contracts are thus characterized by a basic *modus ponens* structure: *if* a specified state (x) materializes, *then* this will give rise to a pre-determined bundle of rights and obligations (y). A relatively straightforward example of a state-contingent contract is a 'bonus' payment conditional upon an employee meeting specified performance targets. Other examples include insurance policies, wagering agreements, and representation, warranty, and indemnity clauses contained in commercial agreements. In the case of derivative contracts, the most important of these state-contingent terms govern each counterparty's payment and delivery obligations, the circumstances in which they will be required to post collateral, and the consequences of counterparty default or insolvency. The basic mechanics of these terms are described in Part II.A.

The development of sophisticated state-contingent contracts is the product of several decades of sustained coordination amongst derivatives dealers and other counterparties. Spearheaded by industry trade associations such as the International Swaps and Derivatives Association, this coordination has resulted in a high degree of contractual standardization within derivatives markets. While it is difficult to measure with any real certainty, it has been estimated that upwards of 90% of all swaps are documented using

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Mechanism of Exchange (Macmillan, London, 1875) (describing the role of money in overcoming this problem).

[61] For a discussion of the role of dealers as reputational intermediaries, *see* Awrey (n 11) at 1142. For a discussion of reputational intermediaries generally, *see* Ron Gilson and Reinier Kraakman, "The Mechanisms of Market Efficiency" (1984), 70:4 Virginia Law Review 549 at 620. In this way, the reputation of derivative dealers can serve as yet another substitute for costly investments in information regarding the creditworthiness of prospective counterparties.

[62] While outside the scope of this paper, this legal architecture also includes the safe harbors from automatic stay and fraudulent transfer provisions under corporate bankruptcy law referred to in Part I.

[63] *See* Ron Gilson, Charles Sabel, and Robert Scott, "Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration" (2009), 109 Columbia Law Review 431 at 452.

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ISDA master agreements and related documentation.[64] Combined with advancements in information technology, this standardization has enabled an increasing degree of automation within derivatives markets: dramatically streamlining the process of trade execution, clearing, and settlement. It has also laid the foundations for the central clearing of derivatives contracts as mandated under Title VII of the Dodd-Frank Act. The trend toward automation within derivatives markets is described in Part II.B. The recent push toward central clearing of derivatives contracts is described in Part II.C.

The intertwined trends toward greater standardization, automation, and central clearing have contributed to the widespread perception that derivatives contracts are becoming more commoditized, more transparent, and more liquid—in short, more like conventional equity and debt securities.[65] Indeed, in many states of the world, this perception borders on an accurate reflection of reality. Specifically, where market participants are fundamentally solvent and the underlying markets are stable and liquid, thousands of derivatives contracts are executed, cleared, and settled without a hitch each and every business day.[66] Yet adopting a narrow understanding of how derivative contracts work during these good times risks fostering a misleading impression about how they work when markets break down, when collateral is scarce and hard to value, or when doubts arise about the solvency of counterparties. It is during these bad times that the limits of state-contingent contracting become apparent, and where other formal and informal mechanisms may be necessary in order to buttress the credibility of the commitments underpinning derivative contracts. The braiding of state-contingent contracting with these other mechanisms is described in greater detail in Part III.

A. Highly Sophisticated and Standardized State-Contingent Contracting

The origins of modern derivatives markets can be traced back to the Bretton Woods system of international monetary and exchange rate management established in the closing days of World War II.[67] The Bretton Woods system played two pivotal roles in the emergence and development of derivatives markets. First, the system imposed strict capital and foreign exchange controls designed to prevent cross-border capital and currency flows that might destabilize the system's fixed exchange rate regime.[68] Firms

[64] *See* Henderson (n 14) at 803.

[65] A related trend has been the migration of trade execution in connection with some highly standardized derivative contracts to so-called 'swap execution facilities'; *see* Evangelos Benos, Richard Payne, and Michalis Vasios, "Centralized Trading, Transparency and Interest Rate Swap Market Liquidity: Evidence from the Implementation of the Dodd-Frank Act", Bank of England Staff Working Paper No. 580 (July 2016), available at http://www.bankofengland.co.uk/research/Documents/workingpapers/2016/swp580.pdf. For a more detailed description of this trend—sometimes referred to as 'swap futurization'—and its regulatory drivers, *see* Gabriel Rosenberg and Jai Massari, "Regulation Through Substitution as Policy Tool: Swap Futurization Under Dodd-Frank" (2013), Columbia Business Law Review 667.

[66] Respondents to the latest ISDA Operations Benchmarking Survey, conducted in 2013, reported processing an average of 30,285 'events' per month (with G15 dealers processing an average of 109,642 events per month); *see* ISDA, ISDA Operations Benchmarking Survey (April 2013) at 5, available at https://www2.isda.org/functional-areas/research/surveys/operations-benchmarking-surveys/. 'Events' for these purposes include trade executions, payment and netting calculations, collateral calls, events of default and termination events, and early terminations.

[67] For a more detailed history of the emergence of modern derivatives markets against the backdrop of the Bretton Woods system, *see* Perry Mehrling, *The New Lombard Street: How the Fed Became the Dealer of Last Resort* (Princeton University Press, Princeton, 2013) at 71-75.

[68] This regime, known as the 'Gold-Exchange Standard', fixed the price at which the currency of each member state could be converted into U.S. dollars. In turn, the price at which the U.S. dollar could be converted into gold was fixed at $USD35 per ounce. The rationale for the Bretton Woods capital and

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seeking to shift capital from one country to another—e.g. for the purposes of building a new plant or capitalizing a new subsidiary—were able to circumvent these controls by entering into so-called 'parallel loans'.[69] These loans were the forbearers of modern swaps.[70] Second, the breakdown of the Bretton Woods system during the early 1970s was accompanied by a period of high inflation and exchange rate volatility.[71] This volatility stimulated demand for new financial instruments that would enable firms to more effectively manage the resulting interest rate and foreign exchange risks.[72]

By the early 1980s, demand for derivatives was being met by a small group of dealers operating primarily in the United States and United Kingdom. These dealers offered a relatively modest range of basic derivatives.[73] These early derivatives were documented in *ad hoc* agreements drafted and negotiated on a transaction-by-transaction basis.[74] Yet as demand for derivatives continued to grow, so too did the time, effort, and back office infrastructure needed to execute, clear, and settle these transactions.[75] The result was a significant transactional backlog, along with a predictable decrease in dealer profit margins.[76] This backlog spurred dealers on both sides of the Atlantic to establish working groups with the objective of developing standard terms for use in connection with the most common derivative contracts.[77] In New York, dealers formed a Documentary Committee in May 1984 in order to explore the possibility of standardizing legal documentation within the nascent interest rate swap market.[78] This committee provided the institutional foundations for what would become the International Swaps and Derivatives Association.[79]

Established in 1985, ISDA is the *de facto* trade association for the global derivatives industry.[80] ISDA's first contribution to the development of standardized legal documentation was the 1985 publication of its Code of Standard Wording, Assumptions, and Provisions for Swaps[81], essentially a glossary of standard terms reflecting then existing practice within the U.S. interest rate swap market.[82] In 1987, ISDA commenced publication of standardized 'master' agreements for interest rate swaps and currency swaps. These master agreements incorporated multiple future transactions between two

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foreign exchange controls was essentially that, absent these controls, capital and currency would move freely to whichever countries offered the best investment opportunities. The free movement of capital and currency would inevitably put strain on the commitment to maintain fixed exchange rates, thus undermining the credibility of the Bretton Woods system.

[69] For a detailed description of how parallel loans worked, *see* Flavell (n 29) at 1.

[70] *See* ibid. at 1-3 and Mehrling (n 67) at 71-75.

[71] For a more detailed description of the breakdown of the Bretton Woods system and its impact, *see* Peter Garber, "The Collapse of the Bretton Woods Fixed Exchange Rate System", in Michael Bordo and Barry Eichengreen (eds.), *A Retrospective on the Bretton Woods System: Lessons for International Monetary Reform* (University of Chicago Press, Chicago, 1993).

[72] Awrey (n 11) at 1140.

[73] Principally interest rate and foreign exchange swaps, options, and forwards; Firth (n 14) at 10-1.

[74] Norman Feder, "Deconstructing Over-the-Counter Derivatives" (2002), 17:3 Columbia Business Law Review 677 at 736.

[75] Firth (n 14) at 10-1.

[76] Ibid.

[77] Ibid. at 10-1-10-2.

[78] In the United Kingdom, the equivalent role was performed by a committee working under the auspices of the British Bankers Association (BBA); ibid. This committee produced the BBA Interest Rate Swap (BBAIRS) terms; *see* BBA, Interest Rate Swap Terms (August 1985).

[79] Firth (n 14) at 10-2.

[80] Today, ISDA represents approximately 850 member dealers, institutional investors, governments, and other major counterparties*; see* "About ISDA", available at: www2.isda.org/about-ISDA/.

[81] *See* www.isda.org/publications/isdamasteragrmnt.aspx [hereinafter, the "Swaps Code"].

[82] Feder (n 74) at 737.

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counterparties under the umbrella of a single legal relationship. Over time, ISDA has expanded the scope of these master agreements to include equity, commodity, credit, and other derivatives.[83] These master agreements have dramatically reduced the drafting, negotiation, and other transaction costs associated with the preparation of the legal documentation used in connection with derivatives transactions.

Today, the vast majority of derivatives are documented using either the 1992 or 2002 ISDA master agreement.[84] The ISDA master agreement consists of a pre-printed form of standard terms, accompanied by a schedule that enables counterparties to amend these terms and make certain tax, documentary, and other elections. The master agreement and schedule codify the legal relationship between the counterparties separate and apart from the legal and economic terms governing any specific transaction. This structure reflects an attempt to balance contractual certainty and flexibility: with the master agreement and schedules articulating the basic parameters within which the counterparties enter into individual transactions.[85] The transactions themselves are then documented in trade confirmations setting out the relevant economic terms, calculation mechanics, and payment and delivery obligations.[86] In order to reduce transaction costs and promote standardization, ISDA has also published a series of booklets, definitions, and other terms that can be incorporated by reference into trade confirmations governing a number of common derivatives transactions.[87] Together, the master agreement, schedule, and trade confirmations are deemed to form a single agreement.[88] In the event of inconsistencies between these documents, a trade confirmation prevails over the schedule, which in turn prevails over the master agreement.[89]

ISDA also publishes a series of standard agreements—known generically as credit support agreements (CSAs) —that govern when and how counterparties will be required to post collateral.[90] These CSAs are tailored to reflect differences in domestic legal regimes governing the transfer of collateral assets including, perhaps most importantly, whether these transfers take place under a title transfer or security interest system.[91] ISDA has also published Collateral Asset Definitions that contain standardized

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[83] ISDA has also developed a series of protocols that facilitate the *ex post* amendment of existing master agreements with a view to, *inter alia*, responding to jurisprudential developments, rectifying perceived technical deficiencies and, more generally, standardizing market practice; *see* www2.isda.org/functional-areas/legal-and-documentation/protocols/.

[84] While a significant number of derivative contracts are still documented using the 1992 master agreement, all references to the ISDA master agreement in this paper will (unless otherwise indicated) be to the 2002 master agreement.

[85] Firth (n 14) at 10-5-10-6.

[86] Confirmations may also amend provisions of the master agreement as they apply to a specific transaction.

[87] Firth (n 14) at 10-6-10-7.

[88] ISDA master agreement, section 1(c).

[89] ISDA master agreement, section 1(b).

[90] These agreements—include the English law Credit Support Annex, English law Credit Support Deed, New York law Credit Support Annex, and Japanese law Credit Support Annex. For a full list of the CSAs published by ISDA, *see* ISDA Credit Support Documentation, available at http://www.isda.org/publications/isdacredit-users.aspx. In 2001, ISDA also published standardized Margin Provisions that could be used in place of a CSA; *see* ISDA, "2001 Margin Provisions Streamline Collateral Process" (16 May 2001), available at http://www.isda.org/press/press5-16-01.html. To date, however, these Margin Provisions have not gained widespread acceptance within the marketplace; Firth (n 14) at 10-6 and 12-39.

[91] For a discussion of the legal and practical differences between title transfer and security interest systems, *see* Firth (n 14) at 6-7-6-33. In a nutshell, whereas title transfer systems contemplate the outright transfer of collateral assets from the collateral provider to the collateral taker, security interest systems contemplate a mere pledge in favour of the collateral taker.

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descriptions of the most commonly used collateral assets.[92] According to the 2015 ISDA Margin Survey, the utilization of CSAs varies across different types of transactions: ranging from a high of over 90% for equity and credit derivatives, to a low of under 60% for commodity derivatives.[93]

Figure 6

ISDA's Contractual Architecture

ISDA Standard Form	Function
Master Agreement	Sets out the basic legal relationship between two counterparties
Schedule	Enables counterparties to amend the master agreement and to make certain elections
Trade Confirmation	Sets out the economic terms, calculation mechanics, and payment and delivery obligations for individual transactions
Booklets, Definitions, and Terms	Provides standardized definitions and other terms for trade confirmations in connection with common transactions
Credit Support Agreement	Defines the circumstances in which counterparties will be required to post or transfer collateral as part of a transaction

Highly sophisticated state-contingent contracting is evident throughout the ISDA master agreement, CSAs, and trade confirmations. This sophistication begins with the basic payment and delivery obligations. As described above, the market risk associated with every derivative contract revolves around one or more state-contingent terms: if *x*, then *y*. As we have seen, *x* can be the price of an asset at a given point in time, an event of default in connection with a corporate bond, or just about any other imaginable future state of the world. Upon the occurrence of *x*, *y* is then the corresponding obligation to deliver the underlying or, more typically, to pay a specified sum of money.[94]

On the surface, these basic payment and delivery obligations may seem relatively straightforward.[95] In practice, however, things can and do go very wrong. In order to proactively address some of the potential problems, ISDA documentation supplements these basic obligations with more detailed provisions around the mechanics of payment and delivery in the event of various contingencies. Trade confirmations, for example, typically stipulate each party's obligations in the event that payment or delivery becomes impossible due to the breakdown of the relevant payment or securities settlement systems.[96] Trade confirmations contemplating payments in emerging market

[92] *See* ISDA, Collateral Asset Definitions (June 2003), available at http://www.isda.org/c_and_a/pdf/isdacollateralassetdef.pdf.

[93] *See* ISDA Margin Survey (August 2015) at 12, available at https://www2.isda.org/functional-areas/research/surveys/margin-surveys/.

[94] Along with the corresponding right to receive payment or delivery.

[95] This is reflected in the ISDA master agreement, which stipulates that—in the absence of anything to the contrary in the trade confirmation—payments and deliveries are to be made "in the manner customary" for the relevant payment or delivery obligation; ISDA master agreement, section 2(a)(ii).

[96] *See* for example, section 9.4 of ISDA Equity Derivative Definitions and section 6.2 of 1997 ISDA government bond option definitions, available at http://www.isda.org/publications/isdaequityderivdefconfir.aspx and http://www.isda.org/publications/isda-govbonddefconf.aspx. The ISDA master agreement also includes detailed provisions around the compensation payable to a party in the event that its counterparty fails to

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currencies, meanwhile, will often identify an alternative payment currency for use in the event that the government issuing the original payment currency imposes foreign exchange controls or other restrictions.[97] These and other provisions enable the continued performance of each counterparty's payment and delivery obligations in circumstances where the failure to provide for these contingencies *ex ante* might otherwise impede the smooth and efficient operation of derivatives markets.

The ISDA master agreement also employs state-contingent contracting to implement payment netting. Where a transaction contemplates that payments are to be made by both counterparties on the same day, and in the same currency, the master agreement provides that payments will automatically be replaced with a single net payment to the counterparty that would have otherwise been obligated to pay the smaller of the two amounts.[98] At the election of the counterparties, payment netting can then be extended to payments made on same day and in the same currency across *multiple* transactions.[99] Through the automatic application of payment netting, the master agreement serves to reduce the number and size of payment obligations, thereby streamlining the payment process and minimizing each party's exposure to counterparty default.

A second—even more sophisticated—set of state-contingent terms govern the obligations of the counterparties under a CSA. In general, counterparties enjoy a great deal of flexibility in the design of collateral arrangements. ISDA's published CSAs include a number of elections regarding, *inter alia*, the frequency of margin calculations, threshold and minimum transfer amounts, and the identity of eligible collateral assets.[100] Nevertheless, ISDA has in recent years taken steps to encourage the standardization of CSAs.[101] As a result, these collateral arrangements have increasingly come to employ a common structure and terminology.

As described in Part I, the collateral posted under a derivative contract falls into one of two categories. The first is initial margin. Initial margin—referred to as the 'Independent Amount' in most CSAs[102]—can be expressed as a fixed sum, an amount per transaction, or as a percentage of the notional amount. The calculation of the Independent Amount can be based on a range of factors including: the creditworthiness of the counterparties; the number, size, and volatility of outstanding transactions, and

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make a payment or delivery; see ISDA master agreement, sections 9(h)(i)(1)-(2) and 14 (definition of "Default Rate").

[97] Firth (n 14) at 11-6. For an example of what can happen if the counterparties fail to specify an alternative payment or delivery mechanism, *see Libyan Arab Foreign Bank* v. *Bankers Trust Co.* [1989] Q.B. 728 [hereinafter, "*Libyan Arab*"]. *Libyan Arab* involved a U.S. dollar account held by the claimant with the London branch of Bankers Trust. Payments in connection with this account were typically made by way of book transfer in New York. When this became illegal under an Executive Order freezing Libyan property in the U.S., the claimant demanded payment in London. The court held that, as there was no express or implied term in the contract requiring payment by way of book transfer, the claimant could demand payment in cash at the branch where the account was held. Given the sums involved, payment in cash was entirely impractical.

[98] ISDA master agreement, section 2(c).

[99] Ibid. This election is made in the trade confirmation.

[100] *See* for example, the elections set out in paragraph 13 of the New York law CSA.

[101] *See* for example, ISDA, "2013 Best Practices for the OTC Derivatives Collateral Process" (23 October 2013), available at https://www2.isda.org/functional-areas/infrastructure-management/collateral/. ISDA has also published a standard CSA; *see* ISDA, "ISDA Publishes 2013 Standard CSA (SCSA)" (7 June 2013), available at http://www2.isda.org/news/isda-publishes-2013-standard-credit-support-annex-scsa.

[102] *See* for example, the New York law CSA, paragraph 14.

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the frequency of variation margin calculations.[103] In general, the larger and more risky a party's exposure to its counterparty, the higher the Independent Amount it will demand as security against counterparty credit risk. The terms governing the Independent Amount will therefore be asymmetric: with the counterparty posing greater risks required to post more collateral.[104] Importantly, where the factors used to calculate the Independent Amount change (e.g. where the creditworthiness of a counterparty deteriorates), the terms of the CSA may envision corresponding changes to the amount of collateral that counterparties are required to post.[105]

The second category of collateral is variation margin. Under a CSA, counterparties maintain a running account of posted collateral known as 'Posted Credit Support'.[106] Variation margin is calculated by periodically comparing the Posted Credit Support against the amount of collateral that each counterparty is required to post pursuant to the terms of the CSA.[107] This second amount is known as the 'Credit Support Amount'.[108] The Credit Support Amount is made up of three components. The first is the 'Exposure'[109]: typically defined as the cost of replacing transactions that fall under the relevant master agreement.[110] In effect, the Exposure is designed to reflect the amount of collateral that would be required to fully insulate a counterparty from losses in the event that the relevant transactions were immediately closed out and any posted collateral liquidated.[111] The second component consists of any Independent Amounts that have been posted by the counterparties. Where a counterparty is required to post variation margin, the Independent Amount is added to the Credit Support Amount; where a counterparty is entitled to receive variation margin, the Independent Amount is deducted from it. The third component is the 'Threshold'.[112] The Threshold represents the size of the residual uncollateralized exposure, if any, that a counterparty is prepared to accept. Where a Threshold is specified, a counterparty will only be required to post collateral where the other counterparty's Exposure exceeds this Threshold.[113]

Variation margin calculations take place on a periodic basis in accordance with the terms of each CSA. Each day on which this calculation takes place is known as a 'Valuation Date'.[114] While comprehensive market data is scarce, ISDA has reported that the majority of CSAs envision daily variation margin calculations, with a minority

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[103] *See* ISDA, "Market Review of OTC Derivative Bilateral Collateralization Practices" (1 March 2010) at 43, available at http://www.isda.org/c_and_a/pdf/Collateral-Market-Review.pdf and Firth (n 14) at 12-6.

[104] Indeed, there is no point in requiring counterparties to post an Independent Amount if these terms are not asymmetric, as the amount of collateral posted by both counterparties will be identical and, therefore, offset. Where both counterparties are required to post an Independent Amount, this collateral will be posted on a net basis by the counterparty required to post the larger of the two amounts.

[105] As described in Section III.C, CSA terms of this variety played an important role in the downfall of AIG.

[106] The Posted Collateral Support is also referred to in some CSAs as the 'Credit Support Balance'; *see* for example, United Kingdom CSA, paragraph 2.

[107] *See* for example, the New York law CSA, paragraphs 3(a) and (b).

[108] Ibid.

[109] Ibid., paragraph 12.

[110] Ibid.

[111] *See* Firth (n 14) at 6-3-6-4 and 12-3-12-4.

[112] *See* for example, the New York law CSA, paragraph 13(E)(iv).

[113] After adjusting for the Independent Amount; ibid., paragraph 3. Counterparties can also agree to 'Minimum Transfer Amounts' that eliminate the obligation to post collateral where the variation margin required in any given period falls below a specified amount. An important distinction between the Threshold and any Minimum Transfer Amount is that, unlike the former, exceeding the latter obligates the relevant counterparty to post the entire amount of required variation margin; ISDA (n 103) at 44.

[114] *See* for example, the New York law CSA, paragraphs 3 and 12.

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requiring weekly or monthly calculations.[115] Where the Credit Support Amount exceeds a party's Posted Collateral Support on any given Valuation Date, that party will be required to post collateral equal to the difference.[116] Conversely, where the Credit Support Amount is less than the Posted Collateral Support, the party will be entitled to a return of collateral from its counterparty.[117] Importantly, the obligation to deliver or return collateral does not arise automatically: it must be demanded by the counterparty entitled to receive the collateral.[118] This demand is known as a margin or collateral 'call'. Following receipt of a collateral call, most CSAs then contemplate that counterparties will post collateral within two business days.[119] Subject to the application of the Threshold, variation margin requirements thus ensure that the value of posted collateral is more or less continually adjusted to reflect any changes in each counterparty's exposure.

Crucially, the value of the collateral posted under a CSA can fluctuate as a result of market volatility.[120] To compensate for these fluctuations, CSAs typically provide that collateral can be valued at a percentage of its full market value—the 'Valuation Percentage'—for the purposes of calculating the Posted Collateral Support.[121] The difference between the collateral's market value and this amount is known colloquially as a 'haircut'. The size of this haircut typically reflects the expected volatility in the price of the relevant collateral asset. Thus, for example, while counterparties will typically not impose haircuts on cash or cash equivalents, they may impose significant haircuts on corporate bonds, long-dated sovereign debt issued by foreign countries, and other risky securities. Whereas initial and variation margin requirements are designed to protect a party against the deterioration of its counterparty's creditworthiness, haircuts are thus designed to provide a buffer against any deterioration in the market value of the posted collateral.

The calculation of variation margin requirements is generally undertaken by one of the counterparties—typically the dealer—known for the purposes of the CSA as the 'Valuation Agent'.[122] The Valuation Agent's primary responsibility is to calculate the Exposure.[123] This calculation necessitates that the Valuation Agent determine the closeout (or replacement) value of the transactions on the basis of prevailing market prices.[124] The Valuation Agent is also responsible for calculating the value of any posted collateral, along with any haircuts on this collateral in accordance with the specified Valuation Percentage.[125] The Valuation Agent must then notify the other counterparty of its calculations, along with the resulting obligation to deliver or return collateral, typically no later than the first business day following a Valuation Date.[126]

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[115] ISDA (n 103) at 44.

[116] Known as the 'Delivery Amount'; *see* for example, the New York law CSA, paragraph 3(a).

[117] Known as the 'Return Amount'; ibid., paragraph 3(b).

[118] This demand must be made promptly following the Valuation Date; ibid., paragraphs 3(a) and (b). Although the counterparties can elect to make this obligation automatic.

[119] The New York law CSA, for example, contemplates that variation margin will be posted the next local business day where the collateral call was made before 12pm New York time, and two local business days if the collateral call was made after this time; ibid., paragraph 4(b), 12, and 13(E)(c)(iv).

[120] This is the case even for cash collateral, the value of which can fluctuate vis-à-vis other currencies.

[121] *See* New York law CSA, paragraphs 12 (the definitions of 'Valuation Percentage', 'Value', and 'Eligible Collateral') and 13.

[122] *See* for example, New York law CSA, paragraphs 12 (definition of 'Valuation Agent') and 13.

[123] Ibid., paragraph 4(c).

[124] Ibid., paragraph 12 (definition of 'Exposure').

[125] Ibid., paragraph 4(c) and 12 (definition of 'Value').

[126] Ibid., paragraph 4(c).

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Finally, the ISDA master agreement includes a number of sophisticated state-contingent terms governing what happens in the event that a counterparty is unable to perform its contractual obligations. For these purposes, the ISDA master agreement distinguishes between two types of events: 'Termination Events' and 'Events of Default'.[127] Termination Events generally apply to circumstances where the inability to perform is viewed as outside a party's control.[128] Termination Events specified in the master agreement include, for example, 'Illegally' events stemming from changes in any applicable law, treaty, rule, or regulation that make it unlawful for a party to perform its obligations under a master agreement, trade confirmation, or CSA.[129] They also include 'Force Majeure' events that render performance "impossible or impracticable".[130] The processes for notifying a party of a Termination Event, any applicable cure periods, and the methodology for calculating the amount due upon termination vary depending upon the type of event and whether one or both counterparties have been affected by it. In all cases, however, the occurrence of a Termination Event will entitle an affected counterparty to closeout any transactions that have been disrupted by the event.[131]

Events of Default, meanwhile, relate specifically to events or circumstances that reflect a material increase in a party's exposure to counterparty credit risk. Events of Default identified in the ISDA master agreement include: the failure of a counterparty to make a payment or delivery[132]; any breach of the other terms of the master agreement[133]; default under a CSA[134]; cross-default under any specified contracts[135], and the bankruptcy of a counterparty.[136] The master agreement then goes into considerable detail regarding what constitutes an Event of Default under each of these headings. The 'bankruptcy' Event of Default, for example, expressly encompasses: dissolution; cash flow insolvency; the institution of a bankruptcy, insolvency, or equivalent process; a general assignment, arrangement, or composition for the benefit of creditors; the passage of a resolution in favour of winding-up, official management, or liquidation, or a secured party taking possession of all or substantially all of a counterparty's assets.[137]

Upon the occurrence of an Event of Default, the non-defaulting counterparty is entitled to closeout all transactions under the relevant master agreement.[138] It can also simply withhold any payments or deliveries that would otherwise fall due under the agreement.[139] This latter entitlement gives the non-defaulting counterparty an opportunity to explore the possibility of remedying the Event of Default before closing

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[127] ISDA master agreement, sections 5(a) and 5(b).

[128] Although, technically speaking, the Termination Events in relation to tax and credit events upon the merger of a party are within that party's control.

[129] ISDA master agreement, sections 5(b)(i) and 14 (definition of 'law').

[130] Ibid., section 5(b)(ii). The master agreement also includes a number of other, more technical, Termination Events relating to changes in tax law and tax and credit events upon the merger of a party to the agreement. Parties may also specify additional Termination Events at their discretion.

[131] Ibid., section 6(b). In the case of Illegality Events of Default, both counterparties will be entitled to closeout affected transactions regardless of whether they are an affected party; ibid., section 6(b)(iv)(2)(A).

[132] Ibid., section 5(a)(i).

[133] Ibid., section 5(a)(ii)(1).

[134] Ibid., section 5(a)(iii).

[135] Ibid., section 5(a)(v) and 5(a)(vi).

[136] Ibid., section 5(a)(vii).

[137] Ibid. For a detailed discussion of these events, *see* Firth (n 14) at 11-27-11-48.

[138] Ibid., section 6(a). This is in contrast with Termination Events, where only *affected* transactions can be closed out.

[139] Ibid, section 2(a)(iii).

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out the transactions.[140] Where the non-defaulting counterparty ultimately elects to closeout transactions, it must generally provide written notice to its counterparty.[141] The non-defaulting counterparty will then typically be responsible for calculating the amount—known as the 'Early Termination Amount'—payable after the application of the closeout netting process described in Part I.[142] When calculating the Early Termination Amount, the non-defaulting counterparty will be required to act in good faith and in a commercially reasonable manner in accordance with a methodology set out in the master agreement.[143] This methodology envisions that, where possible, the non-defaulting counterparty will calculate the replacement cost of the relevant transactions on the basis of dealer quotes or other market data.[144]

Over the course of the past thirty years, the basic legal architecture supporting derivative contracts has thus become increasingly sophisticated and, importantly, highly standardized. This standardization has been a key driver of the growth of derivatives markets. It has also laid the foundations for their increasing automation.

B. Increasing Automation

Between 1990 and 2005, the aggregate notional value of outstanding derivatives contracting grew from approximately $USD3.45 trillion to almost $USD300 trillion.[145] This dramatic growth was accompanied by a corresponding increase in the administrative costs incurred by dealers over the lifecycle of a derivative contract (*see* Figure 7). This lifecycle begins with the *negotiation* of the master agreement, schedules, and any CSA by traders or other 'front office' personnel. Thereafter, each time the counterparties execute a trade confirmation, the resulting transaction must go through the processes of *clearing* and *settlement*. Clearing refers to the processes carried out by compliance and other 'back office' personnel in order to verify the terms of each trade confirmation, periodically calculate amounts owing under a transaction, and reconcile any differences in these terms or calculations as understood by the counterparties.[146] Settlement then takes place on each occasion where the counterparties satisfy their payment or delivery obligations, post or return collateral, or close out a transaction following a Termination Event or Event of Default.

[140] Firth (n 14) at 11-7 ("[section 2(a)(iii) of the ISDA master agreement] gives the parties a degree of breathing space to try to ensure that the Event of Default is remedied").

[141] ISDA master agreement, section 6(a). The counterparties can also elect for automatic early termination upon the occurrence of certain bankruptcy Events of Default; ibid.

[142] Ibid., section 6(e)(i). The Early Termination Amount is effectively determined by calculating the replacement cost of the relevant transactions using market quotations, other market data, or internal quotations (the 'Closeout Amount') and then adding or subtracting, as necessary, certain other amounts due as between the parties (the 'Unpaid Amounts'); ibid., sections 6(e)(i) and 14 (the definitions of 'Closeout Amount' and 'Unpaid Amounts').

[143] Ibid.

[144] Ibid.

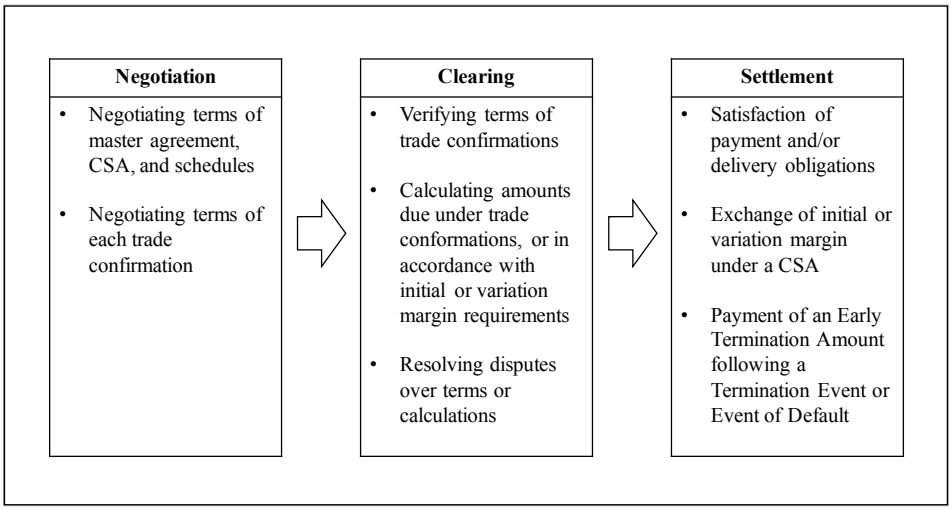
[145] *See* BIS, "OTC Derivatives Market Activity in the Second Half of 2005" (May 2006), Table 1, available at http://www.bis.org/publ/otc_hy0605.pdf (providing aggregate notional amounts for December 2005) and BIS, "International Banking and Financial Market Developments" (August 1996) at 35, available at http://www.bis.org/publ/r_qt9608.pdf (providing aggregate notional amounts for 1990).

[146] This is especially important where transactions are initially agreed by front office personnel communicating via telephone.

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Figure 7

The Lifecycle of a Derivative Contract



Despite the rapid growth of derivatives markets, dealers were initially slow to make investments in the back office infrastructure necessary to ensure the timely negotiation, clearing, and settlement of derivative contracts. A representative example from this period was the build-up of a significant backlog in trade confirmations for many credit derivatives. Between 2002 and 2005, trading volumes in credit derivatives more than doubled from an average of 644 transactions per week to over 1,400.[147] As a result, by September 2005 the fourteen largest credit derivatives dealers had collectively entered into over 150,000 unconfirmed transactions[148]: with approximately 62% left unconfirmed for more than 30 days, and upwards of 41% unconfirmed for more than 90 days.[149] These delays were largely the product of the fact that dealers would manually prepare a trade confirmation and then fax it to their counterparty, who would in turn compare it against their own record of the transaction.[150] If accurate, the counterparty would then fax the signed confirmation back to the dealer.[151] These manual clearing processes were extremely resource intensive and, ultimately, lacked the scalability needed to respond to the rapid growth of derivatives markets.[152]

The widespread use of manual clearing processes exposed derivatives dealers to a number of operational risks. Paramount amongst these risks was that the failure of dealers to confirm transactions and enter them into their information management systems in a timely manner would make it impossible for them to accurately measure and effectively manage both market and counterparty credit risk.[153] In response, the

[147] U.S. General Accountability Office (GAO), "Credit Derivatives: Confirmation Backlogs Increased Dealers' Operational Risks, But Were Successfully Addressed After Join Regulatory Action", GAO-07-716 (June 2007) at 11, available at www.gao.gov/new.items/d07716.pdf.

[148] Ibid.

[149] Ibid.

[150] Along with the practice of assigning trades to third parties without providing notice to the originating dealer; ibid. at 12-13.

[151] Ibid.

[152] Ibid.

[153] The practice of assigning trades without notification also made it difficult for dealers to understand exactly who their counterparties were and, thus, the nature and extent of their exposure to counterparty

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Federal Reserve Bank of New York, Securities and Exchange Commission (SEC), and other regulators launched a joint regulatory initiative in the fall of 2005 targeting the 14 largest credit derivative dealers. The primary thrust of this initiative was, in the short term, to persuade dealers to work together to reduce the backlog of unconfirmed transactions and, over the longer term, to address the underlying problem of underinvestment in back office infrastructure.[154] Amongst other matters, the dealers agreed to streamline their clearing processes, promote the use of electronic clearing and settlement, and coordinate in the development a centralized trade depository.[155] By the end of October 2006, these dealers had successfully reduced the number of credit derivative transactions that remained unconfirmed after 30 days from 150,000 down to 5,500.[156] Four years later, the Federal Reserve Bank of New York observed with pride that of the over 900,000 derivative transactions on the books of Lehman Bros. at the time of its collapse, only one transaction had been subsequently challenged in the bankruptcy process on the basis of an unconfirmed (or 'open') trade.[157]

The resolution of the 2005 credit derivatives confirmation backlog marked a turning point in the development of derivatives markets. Over the course of the next decade, manual clearing processes were gradually replaced by electronic clearing and settlement for many types of derivatives. By 2013, 98% of all credit derivatives, 86% of interest rate derivatives, and 69% of currency derivatives were confirmed electronically (*see* Figure 8).[158] The shift toward electronic trade confirmations has in turn facilitated the automation of many other back office processes: from transaction reconciliation and the calculation of payment and delivery obligations, to the management of initial and variation margin, and electronic settlement. In many cases, dealers and other counterparties now outsource these processes to specialist trade processing platforms such as MarkitSERV.[159] These trade processing platforms aim to provide 'straight through processing': the complete automation of all clearing and settlement events in the lifecycle of a derivative contract. These platforms also serve as centralized depositories for derivatives trading information.

credit risk. Where the failure to confirm trades meant that errors were left undetected, this could also lead to potential legal disputes; ibid. at 14-18. *See* also Rene Stulz, "Credit Default Swaps and the Credit Crisis" (2010), 24:1 Journal of Economic Perspectives 73 at 86-87.

[154] The UK Financial Services Authority was also involved in this initiative; GAO (n 147) at 18.

[155] Ibid. at 20 and 29-30.

[156] Ibid. at 4.

[157] *See* Darrell Duffie, Ada Li, and Theo Lubke, "Policy Perspectives on OTC Derivatives Market Infrastructure", Federal Reserve Bank of New York Staff Report No. 424 (March 2010) at 2, available at https://www.newyorkfed.org/research/staff_reports/sr424.html.

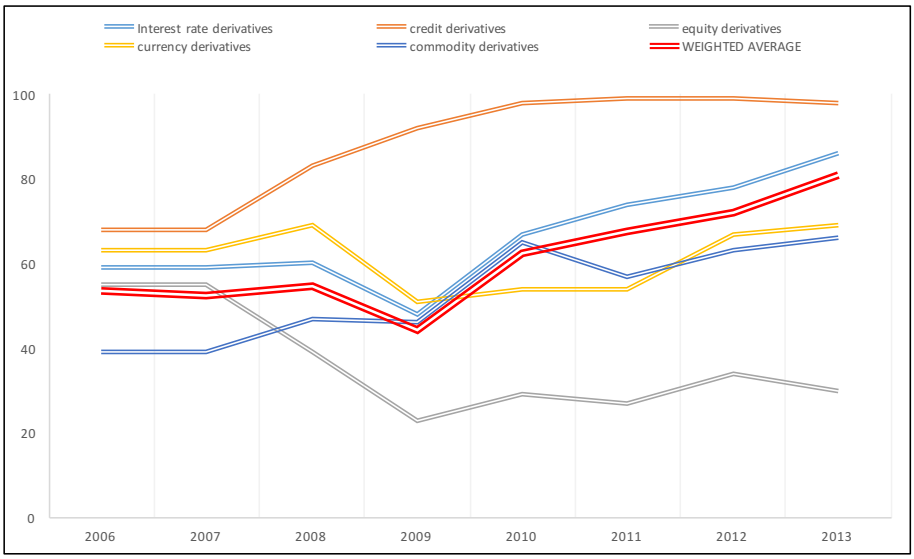
[158] ISDA Operations Benchmarking Survey (n 66) at 8. Unfortunately, 2006 was the first year that ISDA began collecting this information, with the result that there is little comprehensive empirical data against which to assess the impact of the 2005 credit derivatives backlog (or trace the trend toward automation before this point in time).

[159] MarkitSERV was originally a joint venture between Markit and the Depository Trust & Clearing Corporation (DTCC). Markit bought out DTCC's interest in MarkitSERV in 2013.

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Figure 8

Percentage of Derivatives Transactions Confirmed Electronically



Source: ISDA Operations Benchmarking Surveys (2006-2013).

The ability to automate clearing and settlement is ultimately a function of the state-contingent—if *x*, then *y*—structure of derivative contracts. *If* the floating rate on an interest rate swap exceeds the fixed rate as of any given Valuation Date, *then* the counterparty with a negative exposure to upward movements in the floating rate will be required to pay the difference.[160] *If* a party's exposure under a total return equity swap increases beyond a given Threshold, *then* its counterparty will be required to post additional variation margin in accordance with the terms of the relevant CSA. Crucially, this structure opens the door to capturing the key terms of derivative contracts in the form of executable computer code. ISDA and other industry players have capitalized on this opportunity through initiatives such as the development of Financial products Markup Language (FpML). FpML is an open source XML-based standard for electronic execution and processing of derivatives transactions, enabling counterparties to capture the terms of transactions electronically and communicate them to trade processing platforms such as MarkitSERV.[161] ISDA has also played a supporting role in the development of unique trade, product, and legal entity identifiers designed to create a common standard for derivatives transaction reporting.[162] These identifiers are the equivalent of the universal product codes—i.e. barcodes—used to track stock levels at supermarkets and other retail establishments.[163] These and other similar initiatives form the technological backbone of the automated clearing and settlement processes performed by dealers and trade processing platforms.

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[160] The 'difference' in this example being the difference between the fixed and floating rates multiplied by the notional amount (after adjusting for the frequency of settlement dates).

[161] For an overview of FpML, *see* http://www.fpml.org/about/.

[162] For an overview of these initiatives and ISDA's role in their development, *see* http://www2.isda.org/functional-areas/technology-infrastructure/data-and-reporting/identifiers/.

[163] *See* Andy Haldane, "Toward a Common Financial Language", speech to the Securities and Financial Market Association (14 March 2012) at 2-3, available at http://www.bis.org/review/r120315g.pdf.

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Together with the development of standardized contracts, the recent trend toward automation has significantly reduced the costs of clearing and settlement. It has also enhanced the scalability of derivatives markets: with the largest derivatives dealers processing an average of 91,180 transaction lifecycle events per month as of 2013.[164] At the same time, the trend toward automation should not be overstated. The negotiation of master agreements, schedules, and CSAs can still take a considerable amount of time—in many cases weeks, if not months. The trend has also been unevenly distributed across different types of derivatives (*see* Figure 8), with many contracts still too complex to be captured electronically and, thus, still subject to manual clearing and settlement processes. Ultimately, however, the general direction of travel is clear: over the course of the past three decades, derivatives markets have become larger, more standardized, and increasingly automated.

C. The Shift Toward Central Clearing

Historically, the vast majority of derivative contracts have been cleared and settled *bilaterally*: with the counterparties themselves responsible for processing transaction lifecycle events.[165] This bilateral clearing model poses a number of potentially significant risks. First, the complexity of derivative contracts generates acute information problems: both at the level of individual contracts and within the dense networks of interconnected contracts that collectively make up derivatives markets.[166] These information problems raise clear price transparency and investor protection concerns.[167] They also make it difficult for both counterparties and regulators to effectively monitor the build-up of risk within derivatives markets.[168] Second, as described in Part I, derivative contracts are a form of debt. Like all debt, the leverage embedded within derivative contracts can pose significant risks to both institutional and broader financial stability.[169] Finally, the mechanisms that counterparties use to manage counterparty credit risk can exacerbate institutional and systemic instability. Perhaps most importantly, initial and variation margin requirements sensitive to changes in a counterparty's credit rating or market prices introduce the prospect of large and sudden collateral calls at the precise moment when counterparties are facing potentially severe liquidity or solvency constraints.[170] By reducing the pool of assets available to other creditors, these margin requirements—together with closeout netting—can also undermine the liquidity and solvency of other firms.[171]

In the aftermath of the global financial crisis, policymakers in the United States and elsewhere have introduced a number of regulatory reforms designed to address the risks associated with the bilateral clearing model.[172] The objective of these reforms is to promote a shift away from bilateral and toward *central* clearing of derivative contracts.

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[164] ISDA Operations Benchmarking Survey (n 66) at 8.

[165] Or outsourcing responsibility for processing these events to third party trade processing platforms.

[166] *See* Armour et al. (n 41) at 470. *See* also Awrey (n 11).

[167] Armour et al. (n 41) at 470.

[168] Ibid. and Duffie, Li, and Lubke (n 157).

[169] For a discussion of one important dimension of the relationship between leverage and financial instability, see Tobias Adrian and Hyun Song Shin, "Liquidity and Leverage", Federal Reserve Bank of New York Staff Report No. 328 (May 2008), available at https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr328.pdf.

[170] Armour et al. (n 45) at 471-472. *See* also Roe (n 9) and Duffie (n 57).

[171] Roe (n 9). This problem is notably not resolved by central clearing; *see* Richard Square, "Clearinghouses and Liquidity Partitioning" (2014), 99:4 Cornell Law Review 857.

[172] *See* for example, Dodd-Frank Act, Title VII and EMIR.

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Section 723 of the Dodd-Frank Act, for example, makes it unlawful for a counterparty to enter into any swap that meets certain prescribed standardization, liquidity, and other requirements unless that swap has been accepted for central clearing.[173] Central clearing involves the transfer of derivative contracts from the original counterparties to an authorized clearinghouse. The contractual rights and obligations of the counterparties vis-à-vis each other are then replaced by two new mirrored contracts between the clearinghouse and each of the two counterparties.

The potential benefits of central clearing flow principally from the mechanisms that clearinghouses use to manage counterparty credit risk.[174] First, clearinghouses utilize multilateral netting to eliminate offsetting exposures, thereby reducing the overall number and size of payment obligations and, thus, each party's exposure to counterparty default (*see* Figure 9).[175] Second, clearinghouses seek to minimize residual net exposures after multilateral netting by requiring counterparties to post both initial and variation margin. In contrast with the bilaterally clearing model, however—where the relevant terms vary from CSA to CSA—the variation margin required by a clearinghouse is calculated on a daily or even more frequent basis using the same methodology across all derivative contracts of a particular type.[176] Where a counterparty defaults on its obligations, the collateral posted pursuant to these requirements is then used to compensate the clearinghouse for any losses. Third, clearinghouses employ a number of loss sharing mechanisms designed to mutualize the residual risks stemming from the default of one or more of its dealer (or 'clearing') members.[177] These mechanisms include recourse to pre-committed default funds, the clearinghouse's own capital, and contingent capital calls from surviving clearing members. They also include 'position portability' procedures obligating surviving clearing members to assume the contractual rights and obligations of defaulting clearing members. These mechanisms are collectively referred to as a clearinghouse's 'default waterfall'.

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[173] This requirement does not apply to commercial end-users entering into swaps for the purpose of hedging or mitigating commercial risk. When determining whether a swap should be subject to mandatory central clearing, the CFTC must take into account: the aggregate outstanding notional value of the relevant species of swap; the level of market liquidity; the availability of pricing data; the robustness of the infrastructure needed to clear the swap; the effect of central clearing on systemic risk and competition, and the existence of reasonable legal certainty with regards to the treatment of counterparty positions, funds, and property; Dodd-Frank Act, section 723. The SEC has adopted similar rules for swaps falling under its jurisdiction; *see* Process for Submissions for Review of Security-Based Swaps for Mandatory Clearing and Notice Filing Requirements for Clearing Agencies, 77 Fed. Reg. 41,602 (13 July 2012) (codified at 17 C.F.R. § 240.C3a-1, 249). In order to incentivize greater utilization of central clearing, these reforms have been accompanied by the imposition of more onerous capital and margin requirements on bilaterally cleared derivative contracts; *see* Margin and Capital Requirements for Covered Swap Entities, 80 Fed. Reg. 74,840 (30 November 2015) (codified at 12 C.F.R. pts. 45, 237, 349, 624 & 1221) and Margin Requirements for Uncleared Swaps for Swap Dealers and Major Swap Participants, 81 Fed. Reg. 636 (6 January 2016) (codified at 17 C.F.R. pts. 23 & 140).

[174] Armour et al. (n 41) at 472–74. For a more detailed description of the mechanisms that clearinghouses use to address counterparty credit risk, *see* Craig Pirrong, The Economics of Clearing in Derivatives Markets: Netting, Asymmetric Information, and the Sharing of Default Risks Through a Central Counterparty (8 January 2009) (unpublished manuscript), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1340660.

[175] Clearinghouses also use a process known as 'trade compression' to eliminate redundant contracts, thereby reducing the number of contracts outstanding between two counterparties without impacting their net positions.

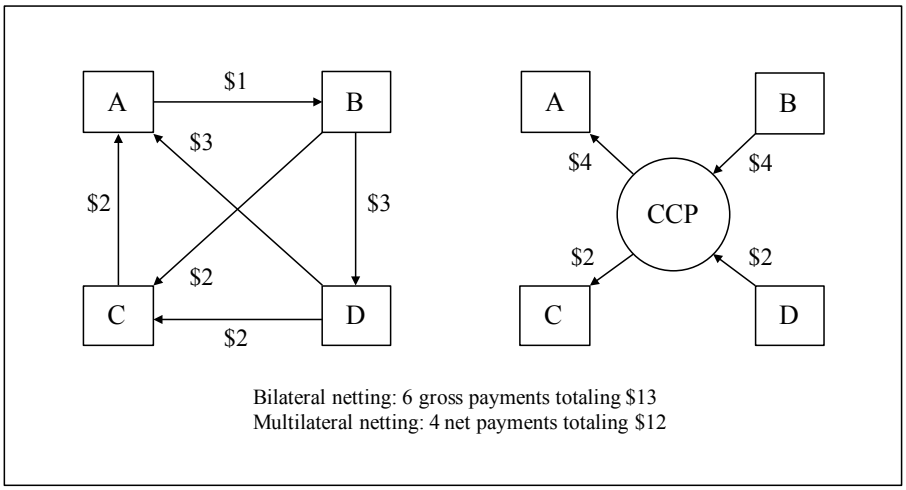
[176] *See* Pirrong (n 174) at 18-20.

[177] Ibid.

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Figure 9

Bilateral versus Multilateral Netting



The push toward central clearing has been accompanied by regulatory requirements designed to enhance the transparency of derivatives markets. Section 727 of the Dodd-Frank Act mandates post-trade reporting of price, volume, and other information for all swap contracts to a registered swaps data repository (SDR).[178] These SDRs include trade processing platforms, along with a number of depositories created by major clearinghouses. The information that must be reported to an SDR at the time a transaction is executed includes: the notional amount of the swap; its stated price; whether either party is a dealer, major swap participant, or financial counterparty; whether the swap is collateralized; the date and time it was executed; and its maturity, termination, or end date.[179] Thereafter, a designated counterparty must also report any changes to the primary economic terms of the swap over the life of the contract.[180] Section 727 also imposes an obligation on SDRs to ensure the real-time public dissemination of certain anonymized information transactional data: including the notional amount of the swap; its stated price; the relevant underlying; whether the swap is bilaterally or centrally cleared; and whether it is collateralized, along with its settlement currency, payment frequency, and effective start and end dates.[181]

Ultimately, the shift toward central clearing and market transparency would not be possible without the parallel trends toward contractual standardization and automation.

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[178] The basic requirement articulated in section 727 is then supplemented by regulatory rules prescribing in greater detail what information is to be reported; *see* Swap Data Recordkeeping and Reporting Requirements, 17 C.F.R. pt. 45 (2012) [hereinafter, the "SDR Reporting Rule"]. In addition to these extensive post-trade reporting and disclosure requirements, section 723 of the Dodd-Frank Act also introduces a limited degree of pre-trade transparency; *see* Awrey (n 11) at 1158-1159.

[179] SDR Reporting Rule, app. 1. SDR Reporting Rule, section 45.8 provides a hierarchy for the purposes of determining which counterparty is required to report the relevant information. *See also* William Meehan and Gabriel Rosenberg, *OTC Derivatives Regulation Under Dodd Frank: A Guide to Registration, Reporting, Business Conduct and Clearing* (Thomson Reuters, New York, 2015) at 72–75.

[180] Ibid. at 75–76.

[181] *See* Real-Time Public Reporting of Swap Transaction Data, 17 C.F.R. pt. 43 (2012) [hereinafter, the "Real-Time Reporting Rule"], app. A. This basic requirement is then supplemented by more detailed rules prescribing what information SDRs are required to disseminate and in what manner, along with a number of exemptions from the basic reporting requirement; ibid.

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The ability of clearinghouses to effectively hedge the risks generated by hundreds of thousands of mirrored derivative contracts requires the legal architecture supporting these contracts to be highly standardized.[182] Standardization is also a necessary precondition to meaningful market transparency. Specifically, where derivative contracts exhibit high levels of legal heterogeneity, this will inevitably undermine the quality of the informational signal sent by prices and, thus, the utility of publicly disseminating trade pricing information.[183] Automation, in turn, is necessary to ensure that clearinghouses can administer the enormous volume of transaction lifecycle events associated with the clearing and settlement of derivative contracts. Automation is also necessary to ensure that transaction information is provided to SDRs on a timely basis, and that SDRs are able to disseminate trade pricing and other information in real time. Viewed from this perspective, the push toward central clearing and enhanced market transparency is likely to generate additional momentum toward greater contractual standardization and automation, which will in turn enable more derivative contracts to be cleared and settled through clearinghouses.

The past three decades have witnessed seismic changes in the size, structure, and importance of derivatives markets. The most significant of these changes include greater contractual standardization, increasing automation, and the recent push toward central clearing. Taken together, these trends paint a picture of increasing homogeneity, transparency, and liquidity: the incremental yet discernible *commodification* of derivatives markets. Importantly, however, these trends only reflect how derivative contracts work under 'normal' market conditions: where markets are deep and liquid, where prices are readily observable, and where contracting parties have no reason to doubt the creditworthiness of their counterparties. They do *not* reflect how they work during periods of fundamental uncertainty. How derivatives work in these bad times is explored in the next section.

III. DERIVATIVES IN BAD TIMES

In light of the sophistication of derivative contracts, one could be forgiven for thinking that they are designed to explicitly cover every possible eventually—from a minor inconsistency between an ISDA master agreement and trade confirmation, to the sudden and unexpected bankruptcy of a counterparty. In reality, however, even these highly detailed state-contingent contracts are fundamentally *incomplete*. This incompleteness exposes counterparties to the risk that their carefully designed contracts will fail to produce efficient outcomes. It also exposes them to the threat of opportunistic behaviour by their counterparties over the life of the contract.

Contracting parties use a number of mechanisms to address these risks. These mechanisms include 'formal' strategies such as the allocation of property or decision-making rights and the use of broad contractual standards. They also include more 'informal' mechanisms such as reputation and the expectation of future dealings. These formal and informal mechanisms can work together with the more detailed state-

[182] *See* Awrey (n 11) at 1154-1155 (describing legal and other forms of 'basis' risk that arise within derivatives markets).

[183] Ibid. at 1124-1138 (describing how legal heterogeneity undermines the informational efficiency of derivatives markets).

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contingent terms of the ISDA master agreement, schedule, and CSAs to provide counterparties with the flexibility to incorporate new information, fill contractual gaps, and promote efficient *ex post* renegotiation. More specifically, while state-contingent terms govern the relationship of the counterparties under normal market conditions, these other mechanisms can play an important role in shaping how counterparties behave during periods of market disruption, institutional instability, and fundamental uncertainty. To borrow a term coined by Ron Gilson, Charles Sabel, and Robert Scott, this "braiding"[184] of state-contingent contracting with other mechanisms enables counterparties to make more credible commitments: incentivizing the use of detailed state-contingent terms in good times by providing a mechanism—a *safety valve*—for modifying or relaxing the strict application of these terms in bad times.[185]

Part III.A identifies the sources of contractual incompleteness, the risks it poses for contracting parties, and the formal and informal mechanisms that parties can use to address these risks. Part III.B examines how these mechanisms are bundled together with the more detailed state-contingent terms at the heart of derivative contracts. To help illuminate how these mechanisms work, how they interact with one another, and their inherent limits, Part III.C then examines a case study involving the renegotiation of a portfolio of credit default swaps between Goldman Sachs and AIG at the height of the global financial crisis.

A. Incomplete Contracting Under Conditions of Uncertainty

In theory, contracting parties can write state-contingent contracts that specify their rights and obligations in each and every potential future state of the world.[186] In practice, however, the vast majority of real world contracts fall far short of this standard of perfect 'completeness'.[187] The pervasiveness of incomplete contracting can be attributed to a number of different factors. As a preliminary matter, contracting parties face the

[184] *See* Ron Gilson, Charles Sabel, and Robert Scott, "Braiding: The Interaction of Formal and Informal Contracting in Theory, Practice, and Doctrine" (2010), 110:6 Columbia Law Review 1377 (defining braiding as a governance tool). *See also* Ron Gilson, Charles Sabel, and Robert Scott, "Contract, Innovation and Uncertainty" in Stefan Grundmann, Florian Moslein, and Karl Riesenhuber (eds.), *Contract Governance: Dimensions in Law and Interdisciplinary Research* (Oxford University Press, Oxford, 2015) and Ron Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience" (2003), 55 Stanford Law Review 1067 (describing the braiding of formal contract and informal reputation in the context of the U.S. venture capital market).

[185] As Gilson, Sabel, and Scott explain: "the two techniques are complements when each strategy reinforces the effectiveness of the other. Thus, an explicit contract that can cover most but not all of the parties' obligations is complimented if the remaining obligations can be enforced informally and the contract as a whole is workable"; Gilson, Sabel, and Scott (2010) (n 184) at 1381.

[186] For an overview of the theoretical literature examining (in)complete contracts, *see* Patrick Bolton and Mathias Dewtrapoint, *Contract Theory* (MIT Press, Cambridge, 2004), chapters 11 and 12. The field of incomplete contracting was pioneered by economists Oliver Hart and John Moore; *see* Oliver Hart and John Moore, "Foundations of Incomplete Contracts" (1999), 66 Review of Economic Studies 115; Oliver Hart and John Moore, "Incomplete Contracts and Renegotiation" (1988), 56 Econometrica 755, and Oliver Hart, "Incomplete Contracts and the Theory of the Firm" (1988), 4 Journal of Law, Economics, and Organization 119.

[187] The concepts of 'completeness' and 'incompleteness' are sometimes used in different ways in the literature; *see* Hart and Moore (1999) (n 184) at 134. 'Obligationally incomplete' contracts fail to fully specify the rights and obligations of the parties in one or more potential future states; *see* Ian Ayres and Robert Gertner, ''Strategic Contractual Inefficiency and the Optimal Choice of Legal Rules'' (1992), 101 Yale Law Journal 729. 'Insufficiently state-contingent contracts', in contrast, are incomplete due to high front- or back-end transaction costs; ibid. For the present purposes, nothing hinges on this distinction and the term 'incomplete' contract is used to encompass both types of incompleteness identified by Ayres and Gertner.

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potentially significant *front-end costs* of designing, drafting, and negotiating ostensibly complete contracts.[188] Writing these contracts demands that parties identify each potential future state of the world, calculate the probability that each state will materialize, understand the position and payoffs of each party in each state and, ultimately, use this information to structure the most efficient bundle of rights and obligations in connection with each possible eventuality.[189] Thereafter, parties also face the *back-end costs* of monitoring compliance with these contracts, along with the costs of verifying to a court, arbitrator, or other third party referee that a given state of the world has in fact materialized.[190] Where these costs exceed the expected benefits of writing a complete contract, we would expect parties to resort to incomplete contracting as a second-best strategy.

In addition to the high costs of writing, monitoring, and enforcing complete state-contingent contracts, parties may also face more fundamental uncertainty about the future. Whereas *risk* relates to future states of the world that can be identified and estimated probabilistically, *uncertainty* in this context refers to the inability to describe a state with sufficient precision or assign a probability to the prospect that this state will materialize.[191] While risk can theoretically be identified, parameterized, and allocated for the purposes of designing state-contingent contracts, uncertainty is thus incapable of being addressed through this type of detailed *ex ante* contracting.[192] The paradigmatic example of uncertainty involves estimating the probability at a given point in time (t_0) that a specific event—e.g. the invention of the wheel—will occur in some future period (t_1). It is simply not possible to write a state-contingent contract at t_0 conditional on the invention of the wheel at t_1: to have written such a contract is to have satisfied the very condition upon which the contract is premised! Where it exists, this type of fundamental uncertainty will therefore represent an insurmountable barrier to writing complete state-contingent contracts.[193]

Finally, the ability of parties to write complete state-contingent contracts may be constrained by bounded rationality and cognitive failure.[194] The concept of bounded

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[188] Numerous scholars have identified these front-end contracting costs as a barrier to (complete) contracting; *see* for example, Ronald Coase, "The Nature of the Firm" (1937), 4 Economica 385; Oliver Williamson, "Transactions-Cost Economics: The Governance of Contractual Relations" (1979), 22:2 Journal of Law and Economics 233, and Kathryn Spier, "Incomplete Contracts and Signalling" (1992), 23:3 Rand Journal of Economics 432. *See also* Hart and Moore (1999) (n 195); Hart and Moore (1988) (n 195), and Hart (n 186).

[189] *See* for example Robert Scott and George Triantis, "Anticipating Litigation in Contract Design" (2006), 115 Yale Law Journal 814 at 823. *See also* Charles Goetz and Robert Scott, "Principles of Relational Contracts" (1981), 67 Virginia Law Review 1089.

[190] For a more detailed description of the back-end costs of verifying contracts, *see* Scott and Triantis (n 189) at 825-834.

[191] This distinction was first advanced by Frank Knight; *see* Frank Knight, *Risk, Uncertainty and Profit* (Houghton Mifflin Co., Boston, 1921).

[192] Gilson, Sabel, and Scott (2015) (n 184) at [4].

[193] In reality, of course, contracting parties will often face a mix of high front and back-end costs and fundamental uncertainty—thus making the distinction between risk and uncertainty difficult to disentangle as a practical matter. This distinction will be particularly hard to make out where transaction costs are extremely high, where the probability that a given state of the world will materialize is extremely low, or where contracting parties attempt to contract into the distant future. Accordingly, the term 'fundamental uncertainty' as used in this paper encompasses both (i) true (i.e. 'Knightian') uncertainty and (ii) circumstances in which high transaction costs and other factors effectively prevent complete *ex ante* contracting.

[194] Robert Scott, "Conflict and Cooperation in Long-Term Contracts" (1987), 75:6 California Law Review 2005 at 2010 and Robert Scott, "Error and Rationality in Individual Decision-Making: An Essay

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rationality encompasses cognitive and temporal limits on a party's ability to absorb and process information.[195] The sources and types of bounded rationality have in recent years been the subject of a rich and growing body of empirical literature documenting systematic failures in human judgment and decision-making.[196] These failures include *framing effects* (the tendency to be influenced by how information is presented), *availability bias* (the tendency to be influenced by the most immediate or proximate examples), *anchoring* (the tendency to be influenced by the first information presented), and *loss aversion* (the tendency to prefer the avoidance of losses to the receipt of equivalent gains).[197] These cognitive failures can impose severe constraints on the ability of contracting parties to identify potential future states of the world, to accurately assess the probability that they will occur and, ultimately, to write the detailed state-contingent contracts necessary to efficiently allocate risk in each potential state.[198]

Incomplete contracts expose parties to two principal risks. The first risk is that these contracts will fail to prescribe an efficient allocation of rights and obligations in some future states of the world. Thus, for example, a contract could fail to identify the rights and obligations of the parties in one or more states, or allocate rights and obligations in a way that generated suboptimal payoffs. The second risk is that a party will take advantage of this incompleteness to behave opportunistically. Where an incomplete contract is revealed to be *ex post* inefficient, the parties should possess powerful incentives to renegotiate it.[199] However, where the relationship is characterized by an asymmetry of bargaining power, the more powerful party may seek to use this renegotiation to extract the entire value of the resulting efficiency gains.[200] This threat of opportunism—or 'hold-up'—will be particularly accurate where only one party has made relationship or asset-specific investments, or where the contract contemplates the sequential performance of obligations.[201] Where this threat exists, the effect will be to

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on the Relationship Between Cognitive Illusions and the Management of Choices" (1986), 59 Southern California Law Review 329 at 332-347.

[195] Bounded rationality is a semi-strong form of rationality pursuant to which economic actors are assumed to be "intendedly rational, but only limitedly so."; Oliver Williamson, *The Economic Institutions of Capitalism* (The Free Press, New York, 1985) at 11, quoting Herbert Simon, *Administrative Behavior* (The Free Press, New York, 1957) at xxiv.

[196] For a survey of this literature, *see* Nicholas Barberis and Richard Thaler, "A Survey of Behavioral Finance" in George Constantinides, Milton Harris, and René Stulz, (eds.), *Handbook of the Economics of Finance* (Elsevier, Amsterdam, 2003). *See also*, Daniel Kahneman, *Thinking, Fast and Slow* (Penguin, London, 2011).

[197] For a more detailed description of each of these and other cognitive failures, *see* Kahneman (n 196).

[198] For some of the recent legal scholarship examining these failures in a contractual setting, *see* David Hoffman and Tess Wilkinson-Ryan, "The Psychology of Contract Precautions" (2013), 80 Chicago Law Review 395 and Tess Wilkinson-Ryan, "The Behavioral Paradox of Boilerplate" (2017), 103 Cornell Law Review [forthcoming].

[199] *See* Ron Gilson, Charles Sabel, and Robert Scott, "Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration", European Corporate Governance Institute Working Paper No. 118 (December 2008) at 27 (describing how renegotiation can ensure both *ex ante* and *ex post* efficiency in the face of uncertainty); Hart and Moore (1999) (n 186) at 115 (identifying the costs of *ex ante* contracting and describing how the renegotiation of incomplete contracts can give parties an opportunity to revisit the contract in light of realized states of the world), and Scott (1987) (n 194) at 2008 (characterizing incomplete contracts as containing an implicit agreement to renegotiate the contract in response to future developments).

[200] Gilson, Sabel, and Scott (n 199) at 27-28.

[201] *See* Benjamin Klein, Robert Crawford, and Armen Alchian, "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process" (1978), 21:2 Journal of Law and Economics 297; Oliver Williamson, "Credible Commitments: Using Hostages to Support Exchange" (1983), 73:4 American Economic Review 519, and Williamson (n 40).

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discourage parties from writing detailed state-contingent contracts in the presence of high levels of risk or uncertainty about the future.

Economic theorists have identified a variety of formal and informal mechanisms that contracting parties can employ to address these risks. The formal mechanisms fall into three broad categories.[202] The first mechanism involves the allocation of *property rights* to the party vulnerable to opportunism.[203] In effect, the residual control rights associated with property ownership enable parties to take unilateral action upon the occurrence of specified contingencies—thereby protecting these parties against the risk of hold-up and other forms of opportunism.[204] The principal benefit of this mechanism is thus its inherently self-executing nature: the party can simply exercise its residual control rights.[205] This is especially useful where *ex ante* relationship or asset-specific investments are costly to specify or observe, but where materialized states of the world are easily and objectively observable.[206]

The second involves the allocation of *decision-making* rights.[207] For example, contracting parties can agree that, in the event that a contract was revealed to be incomplete in some material respect, one party would have the right to determine the most efficient course of action. Like property rights, the principal benefit of this mechanism thus stems from the fact that the party allocated these decision-making rights can take unilateral action. By specifying who has authority to make decisions in a given state of the world—but not specifying particular courses of action—this mechanism also gives parties the flexibility to incorporate new information into the decision-making process. Simultaneously, of course, the benefits of this mechanism hinge on how easy it is to identify which party is likely to be the most vulnerable to opportunism.[208] Even where this is unclear, however, the parties can still ameliorate the attendant risks by allocating decision-making rights to independent third parties.

The third formal mechanism for addressing the risks posed by incomplete contracting involves the use of *broad contractual standards* to demarcate the acceptable range of behaviour. Examples of these standards include contractual terms requiring parties to use their 'best efforts', obligating them to act in 'good faith' or in a 'commercially reasonable' manner, or imposing fiduciary duties.[209] These standards

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[202] Theoretically, parties can also specify *ex ante* a desired outcome and then bargain over how best to achieve that outcome in light of the realized state of the world; *see* Jean Tirole and Eric Maskin, "Unforeseen Contingencies and Incomplete Contracts" (1999), 66 Review of Economic Studies 83. Ultimately, however, this strategy is likely to be extremely costly; Hart and Moore (1999) (n 186) at 118. Where realized states of the world are costly to observe, this strategy may also give rise to opportunism.

[203] Sanford Grossman and Oliver Hart, "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration" (1986), 94:4 Journal of Political Economy 691. In theory, the parties can also allocate these rights to independent third parties.

[204] Grossman and Hart (n 203) and Bolton and Dewatripont (n 186) at 499. Notably, Grossman and Hart's view of property as representing residual control rights contrasts with earlier views of property as representing residual cash flow rights; *see* for example, Jensen and Meckling, "Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure" (1976), 3:4 Journal of Financial Economics 305.

[205] Bolton and Dewatripont (n 186) at 506.

[206] Ibid. at 504-505. Where these states of the world are not easily observable, however, this mechanism poses the risk of 'contrived expropriation': i.e. that the party will exploit this lack of observability to opportunistically exercise its residual control rights; Williamson (n 201).

[207] *See* Ian Macneil, "Contracts: Adjustment of Long-Term Economic Relations Under Classical, Neoclassical, and Relational Contract Law" (1978), 72 Northwestern University Law Review 854 at 868-869 and Gilson, Sabel, and Scott (n 199) at 29-30.

[208] Ibid. at 28.

[209] *See* Macneil (n 207) at 866-868 and Scott and Triantis (n 189). *See* also Mariana Pargendler, "Modes of Gap Filling: Good Faith and Fiduciary Duties Reconsidered" (2008), 82 Tulane Law Review

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provide a benchmark against which courts, arbitrators, and other third parties can evaluate the conduct of the parties in light of realized states of the world. The benefits of standards-based contracting thus stem from the fact that these third parties will be armed with information that the parties themselves did not possess at the time of contracting.[210] By the same token, relying on third parties to evaluate the behaviour of contracting parties on the basis of broad standards necessitates that this behaviour is both easily observable and, crucially, verifiable.[211] Where this behaviour is not susceptible to verification, contracting parties will face a heightened risk that the adjudicator will fail to properly apply the relevant standard.

The risks posed by incomplete contracting can also be addressed through a variety of more informal mechanisms. These mechanisms include ethical norms, culture, religion, personal relationships, and prevailing industry practices.[212] Two important mechanisms in the context of many commercial relationships are reputation and the expectation of future dealings.[213] The expectation of future dealings reflects the willingness of Party A to continue to do business with Party B in light of Party B's behaviour over the course of their relationship. Where Party B behaves cooperatively (or opportunistically), this is likely to have a positive (negative) impact on Party A's willingness to deal with Party B going forward. Reputation, meanwhile, reflects the willingness of other market participants to do business with Party B in light of its observed behaviour towards Party A.[214] Viewed from this perspective, both reputation and the expectation of future dealings rely on the same fundamental threat—the loss of future revenue—to constrain opportunism and promote efficient renegotiation of incomplete contracts.[215] The repeat interactions upon which these mechanisms are based can also be viewed as creating a reserve of goodwill that can be tapped for the purposes of resolving contractual disputes.[216] As with property and decision-making

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1315; Frank Easterbrook and Daniel Fischel, "Contracts and Fiduciary Duty" (1993), 36:1 Journal of Law and Economics 425, and Oliver Hart, "An Economists View of Fiduciary Duty" (1993), 43:3 University of Toronto Law Journal 299.

[210] *See* Ron Gilson, Charles Sabel, and Robert Scott, "Text and Context: Contract Interpretation as Contract Design" Columbia Law School Working Paper No. 469 (1 February 2014) at 38.

[211] Whereas 'observability' refers to the ability of *contracting parties* to observe a given action or state of the world, 'verifiability' refers to the ability of *third parties* to verify these actions or states.

[212] There is a large body of scholarship examining how these mechanisms work in various contexts; *see* for example, Lisa Bernstein, "Private Commercial Law in the Cotton Industry: Creating Cooperation Through Rules, Norms, and Institutions" (2001), 99 Michigan Law Review 1724; Robert Ellickson*, Order Without Law: How Neighbours Settle Disputes* (Harvard University Press, Cambridge, 1994); Avner Greif, "Contract Enforceability and Economic Institutions in Early Trade: The Maghribi Traders' Coalition" (1993), 83 American Economic Review 525; Lisa Bernstein, "Opting Out of the Legal System: Extralegal Contractual Relations in the Diamond Industry' (1992), 21:1 Journal of Legal Studies 115; Rene Sacasas and Don Wiesner, "Comfort Letters: The Legal and Business Implications" (1987), 104 Banking Law Journal 313, and Janet Landa, "A Theory of the Ethnically Homogenous Middleman Group: An Institutional Alternative to Contract Law" (1981), 10 Journal of Legal Studies 349.

[213] *See* generally Benjamin Klein and Keith Leffler, "The Role of Market Forces in Assuring Contractual Performance" (1981), 89 Journal of Political Economy 615 (describing both the potential role and limits of reputation as a mechanism for incentivizing contractual performance).

[214] Viewed from this perspective, the key reputational concern is whether the relevant party can be trusted to behave cooperatively, and not opportunistically, in the context of matters that are subject to incomplete contracting.

[215] *See* Alan Schwartz and Robert Scott, "Contract Theory and the Limits of Contract Law" (2003), 113 Yale Law Journal 541 at 546 and Benjamin Klein, "Why Hold-Ups Occur: The Self-Enforcing Range of Contractual Relationships" (1996), 34 Economic Inquiry 444. *See* also, Stewart MacCauley, "Non-Contractual Relations in Business: A Preliminary Study" (1963), 28:1 American Sociological Review 1 at 14.

[216] MacCauley (n 215) at 15.

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rights, the sanctions associated with these informal mechanisms are essentially self-executing: in response to opportunistic behaviour a party can adopt a less cooperative posture or simply stop doing business with its counterparty.[217]

The ability of reputation and the expectation of future dealings to constrain opportunistic behaviour are subject to important limits. First, where the expected benefits of opportunistic behaviour exceed the expected loss of future revenue, these mechanisms will not serve as an effective deterrent. Along the same vein, these mechanisms are unlikely to constrain opportunistic behaviour where a party believes its counterparty is in the vicinity of insolvency, or where its own survival constraint is threatened. Second, the influence of these mechanisms is likely to be muted in the absence of meaningful competition. Specifically, as the number of substitutes for a good or service decreases, so too does the credibility of a party's threat to stop doing business with a party supplying these goods and services. Finally, in order for these mechanism to provide a credible constraint against opportunism, the behaviour in question must be easily and objectively observable: either by the party vulnerable to opportunism (in the case of the expectation of future dealings) or by the wider community or marketplace (in the case of reputation).[218] For this reason, it is often argued that reputational constraints are most effective in the context of small, close-knit, and homogeneous communities.[219]

Along with more formal mechanisms for addressing the risks posed by incomplete contracting, reputation and the expectation of future dealings can thus help contracting parties incorporate new information, fill contractual gaps, and facilitate efficient *ex post* renegotiation. When braided with detailed state-contingent contracting, the flexibility associated with these mechanisms can thereby promote long-term contracting under conditions where the combination of high levels of risk and uncertainty might otherwise prevent the parties from contracting at all.[220] Furthermore, the self-executing nature of many of these mechanisms will almost invariably be less costly than seeking formal legal enforcement of state-contingent contracts through the courts.[221] As Gilson, Sabel, and Scott observe, this helps explain why parties will often rely on informal mechanisms even where formal remedies for breach of contract are available.[222] Conversely, where these informal mechanisms breakdown, contracting parties will have little recourse other than formal contractual enforcement.[223]

B. Bundling State-Contingent Contracting with Other Formal Mechanisms

The counterparties to derivative contracts face a myriad of potentially significant risks. These risks include both market and counterparty credit risk, along with liquidity

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[217] Schwartz and Scott (n 215) at 557.

[218] See Gilson, Sabel, and Scott (2010) (n 184) at 1394; Bernstein (2001) (n 212); Bernstein (1992) (n 212), and Scott (1987) (n 194).

[219] *See* Ellickson (n 212); Greif (n 212); Bernstein (2001) (n 212); Bernstein (1992) (n 212), and Landa (n 212). As Lisa Bernstein has observed in the context of the U.S. cotton industry, these constraints can also be effective where market participants are connected through an influential industry trade association; Bernstein (2001) (n 212).

[220] *See* Gilson, Sabel, and Scott (2010) (n 184).

[221] Where time, attorneys' fees, court courts, and the risk of judicial error all generate potentially significant costs; ibid.

[222] Ibid., citing MacCauley (n 215).

[223] Schwartz and Scott (n 215) at 546. The incentives to pursue formal enforcement will be especially powerful where the innocent party has made significant asset or relationship-specific investments, or where its counterparty's failure to perform its obligations threatens the party's very survival.

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risk[224], operational risk[225], and the legal and economic basis risks associated with managing a portfolio of derivative contracts.[226] In many cases, the identification, evaluation, and management of these risks can be extremely costly.[227] Counterparties also face significant uncertainty about the future: e.g. about how markets and institutions will evolve over time, and the sources, timing, and potential impact of financial instability. This risk and uncertainty can crystallise in millions of different ways, thus theoretically requiring contracting parties to identify and evaluate the payoffs under millions of different potential outcomes. Writing detailed state-contingent contracts that exhaustively cover these outcomes would be prohibitively costly, thus exposing counterparties to the risks of both *ex post* inefficiency and potential opportunism.[228]

Given the inevitability of incomplete contracting, it should come as no surprise that counterparties use a range of formal and informal mechanisms in order to enhance the credibility of their commitments. The first mechanism is the allocation of property rights in the form of collateral.[229] As described in Part II.A, counterparties will often be required to post initial margin—the Independent Amount under a CSA—at the outset of a transaction. Thereafter, counterparties will periodically adjust the amount of Posted Credit Support in accordance with applicable variation margin requirements. Upon the occurrence of specified Termination Events or Events of Default, the collateral taker can then seize and liquidate posted collateral rather than having to incur the time and expense of pursuing formal legal enforcement.[230] By requiring parties to post collateral against residual net exposures, these initial and variation margin requirements can thus help protect counterparties against the risks generated by any unexpected change in circumstances, or in the event that a counterparty defaults on its contractual obligations.

The allocation of property rights can also play two important and complimentary roles in protecting vulnerable counterparties against the threat of opportunism. First, insofar as it can be used as a substitute for relationship-specific investments in *ex ante* screening and *ex post* monitoring of counterparty creditworthiness, collateral can help

[224] 'Liquidity risk' in this context refers to the risk that a counterparty will not be able to enter into an offsetting or replacement contract on a timely basis and at a price that reflects the underlying economics of the transaction; *see* Brunnermeier and Pedersen (n 59).

[225] 'Operational risk' in this context refers to the risk that a counterparty will fail to implement robust processes, systems, and controls to measure, monitor, and manage the risks associated with derivative contracts.

[226] 'Basis risk' in this context refers to the risk that two theoretically offsetting derivative contracts actually differ in some material way as a result of differences in their legal and/or economic terms; *see* Awrey (n 11) at 1155.

[227] *See* Morgan (n 40) (documenting unusual splits in the credit ratings of large financial institutions). *See also* Hamid Mehran, Alan Morrison and Joel Shapiro, 'Corporate Governance and Banks: What Have We Learned from the Financial Crisis?', Federal Reserve Bank of New York Staff Report No. 502 (1 June 2011), available at https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr502.pdf.

[228] As described above, the idiosyncratic nature of counterparty credit risk means that these investments will be largely non-recoverable, thus giving rise to potential hold-up problems; *see* Part I. These risks will be particularly acute where parties have made significant relationship-specific investments by, for example, rigorously screening and monitoring the creditworthiness of their counterparties.

[229] Several scholars have identified the provision of collateral, along with the related concept of 'hostages', as a governance mechanism; *see* for example, Williamson (n 201) and Anthony Kronman, "Contract Law and the State of Nature" (1985), 1 Journal of Law, Economics and Organization 5 at 15-16.

[230] Viewed from this perspective, the safe harbors for derivatives under corporate bankruptcy law can be understood as designed to ensure that this mechanism is self-executing in circumstances where the application of an automatic stay or fraudulent transfer rules would otherwise prohibit unilateral enforcement (especially under security interest systems, where counterparties would not otherwise enjoy residual control rights over collateral assets).

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ameliorate potential hold-up problems.[231] Second, where a party has posted collateral, the threat that its counterparty might withhold it in response to any opportunistic behaviour can serve as a powerful 'hostage' or deterrent.[232]

The second mechanism that counterparties use to address the risks posed by incomplete contracting is the allocation of decision-making rights. An illustrative example is the appointment of a Valuation Agent. As described in Part II.A, the Valuation Agent is the counterparty responsible for calculating the Exposure for the purposes of calculating variation margin requirements, the value of posted collateral, and any Early Termination Amount due upon the occurrence of a Termination Event or Event of Default.[233] The appointment of a Valuation Agent reflects the fact that variation margin requirements and closeout netting rely on input variables that can only be determined *after* the parties have entered into the contract. Where these variables are based on observable market prices, the role of the Valuation Agent is essentially administrative: simply identifying the relevant market prices and inputting them into the formulas set out in the ISDA master agreement and CSA. However, where assets are thinly-traded, where the underlying markets are opaque or have broken down, or where the underlying is not actually traded in a market, the Valuation Agent will often enjoy considerable discretion over the methodologies for calculating these input variables.[234] These methodologies include so-called 'mark-to-model' approaches to valuation that seek to price assets on the basis of theory-driven financial models as opposed to prevailing market prices. The Valuation Agent mechanism thus not only enables counterparties to incorporate information that will only be revealed over the life of a derivative contract, but also ensures that the variation margin and closeout netting mechanisms at the heart of these contracts will continue to function even when this information is not available.

Importantly, where market prices or other input variables are not easily observable, the allocation of decision-making rights to a Valuation Agent will leave the other counterparty vulnerable to opportunism. Specifically, the Valuation Agent may exploit this lack of observability to calculate variation margin requirements or collateral values in ways that shift the economics of the transaction in its favour. Derivative contracts employ several mechanisms to address this vulnerability. The first is a dispute resolution mechanism. Where a dispute arises in connection with the calculation of variation margin requirements, for example, the Valuation Agent is generally required to obtain quotes for replacement transactions from several dealers.[235] The Valuation Agent must then use the arithmetic average of these quotes to calculate the applicable margin requirements.[236] Where disputes relate to the value of posted collateral, meanwhile, the Valuation Agent is required to use the prevailing bid price of the

[231] Williamson (n 201). *See also* Holmstrom (n 47) at 6 and Awrey (n 11) at 1150-1151.

[232] As Anthony Kronman has observed, there is a subtle difference between 'collateral' and a 'hostage'. Whereas collateral is designed to confer a benefit on the collateral taker, a hostage is designed to impose a cost on the collateral provider; Kronman (n 229) at 15-16. In the context of derivative markets, the fact that the relevant assets are typically valuable to both the collateral taker and collateral provider means that this mechanism performs both an insurance (collateral) and deterrent (hostage) function.

[233] *See* for example, the New York law CSA, paragraph 4(c). The Valuation Agent is also responsible for calculating distributions and interest on posted collateral; ibid., paragraph 6(d).

[234] Ibid., paragraph 5(i)(B).

[235] Ibid.

[236] Ibid.

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securities on the exchange on which they are listed or, where they are listed on an exchange, obtain a dealer quote.[237]

Where market prices or quotations are not readily available, the Valuation Agent will continue to enjoy residual discretion over the methodology for calculating both variation margin requirements and the value of posted collateral.[238] To help constrain the risk of opportunism associated with this discretion, CSAs then employ standards-based contracting: requiring the Valuation Agent to undertake calculations "in accordance with standard market practice".[239] This standard is supplemented by the imposition of a general duty on both counterparties to perform their obligations under the CSA—including all calculations, valuations, and determinations—"in good faith"[240] and "in a commercially reasonable manner".[241] Finally, where a Valuation Agent defaults on its obligations under a derivative contract, CSAs typically shift responsibility for performing closeout netting calculations to a third party designated by the non-defaulting counterparty.[242] This reallocation of decision-making rights is designed to protect the non-defaulting counterparty from the risk that the defaulting counterparty will use their position as Valuation Agent to manipulate the value of the Early Termination Amount or the timing of the calculation and payment process.

The Valuation Agent mechanism is not the only example of standards-based contracting within ISDA's contractual architecture.[243] In addition to the detailed state-contingent terms governing each counterparty's settlement obligations, the ISDA master agreement provides that all payments and deliveries must be made "in the manner customary" for the relevant payment or delivery obligation.[244] Counterparties must also exercise "reasonable care" to ensure the safe custody of posted collateral.[245] The use of broad standards in this context injects a degree of flexibility into each counterparty's obligations. This reflects both the existence of a wide variety of different settlement and custody models across derivative contracts, underlying assets, and jurisdictions and, importantly, the need to keep up with the rapid pace of technological change in the area of payment, custody, and settlement systems.[246] The ISDA master agreement similarly requires counterparties to use "all reasonable efforts" to maintain any government authorizations and consents necessary to enter into derivative contracts, and to obtain any authorizations and consents that may become necessary in the future.[247] Once again, the flexibility associated with this standard is advantageous in a world where regulation

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[237] Ibid., paragraph 13(f)(ii). Where no bid price (quote) is available on a Valuation Date, the Valuation Agent can use the bid price (quote) "for the day next preceding such date on which such prices were available"; ibid.

[238] Ibid., paragraph 5(i)(B) ("if no quotations are available for a particular Transaction (or Swap Transaction), then the Valuation Agent's original calculations will be used for that Transaction (or Swap Transaction)").

[239] Ibid., paragraph 13(c)(i).

[240] Ibid., paragraph 11(d).

[241] Ibid.

[242] Ibid., paragraph 13(c)(i). This third party must be a financial institution that would qualify as a market-making dealer; ibid.

[243] In addition to the examples described below, the ISDA master agreement employs standards-based contracting in a number of other contexts; *see* for example, ISDA master agreement, sections 6(d)(i) (requiring counterparties to undertake calculations upon any early termination as soon as "reasonably practicable") and 6(f) (requiring counterparties to act in "good faith" and use "commercially reasonable" procedures when undertaking currency conversions).

[244] Ibid., section 2(a)(ii).

[245] *See* for example, the New York law CSA, paragraph 6(a).

[246] For an overview of the technological change in this area, *see* Armour et al. (n 45), chapter 18.

[247] ISDA master agreement, section 4(b).

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is both voluminous and constantly changing and where, accordingly, the use of more detailed or prescriptive terms to codify these obligations would be highly impractical.

C. The Role of Reputation and the Expectation of Future Dealings

Collateral, Valuation Agents, and standards-based contracting can each help fill important gaps in the sophisticated state-contingent terms at the heart of derivative contracts. Yet these formal mechanisms for addressing the risks posed by incomplete contracting are themselves far from perfect. Collateral is expensive. The valuation of many financial assets is a notoriously complex and subjective process. Going to a court or arbitrator to enforce broad contractual standards can be extremely costly and unpredictable. These imperfections carve out a potentially significant role for informal mechanisms such as reputation and the expectation of future dealings. In theory, the idea that the behaviour of commercial parties could be influenced by their desire to maximize potential future revenue streams is hardly contentious. As Stewart MacCauley wryly observed in his ground-breaking 1963 study of the importance of informal mechanisms in business relationships: "Suing a customer who is not bankrupt and might order again is poor strategy".[248] In practice, however, it is often difficult to measure the impact of these mechanisms in the real world.[249] Indeed, we might expect this to be particularly difficult within derivatives markets, where the negotiation—and *renegotiation*—of contracts takes place almost entirely behind closed doors. Thankfully, the global financial crisis has provided us with a window into the dynamics of the renegotiation process under conditions of fundamental uncertainty. This window involved the renegotiation of a portfolio of credit default swap (CDS) contracts between AIG and Goldman Sachs.

The rise and fall of global insurance giant AIG has been well documented.[250] Before its spectacular collapse in September 2008, AIG was an important player in the global CDS market: underwriting billions of dollars in credit protection on corporate debt, regulatory capital, and multi-sector collateralized debt obligations (CDOs).[251] The counterparties to these swap contracts included major derivative dealers including Bank of America, Deutsche Bank, Société General, and Goldman Sachs.[252] As of September 2008, approximately 77% of the CDOs in AIG's multi-sector CDO book—totalling roughly $USD55 billion—contained securities linked to the U.S. sub-prime mortgage market.[253] As conditions in this market deteriorated between 2005 and 2007, the resulting decline in both the market prices and credit ratings of the CDOs in AIG's portfolio triggered collateral calls under the CSAs it had entered into alongside the

[248] MacCauley (n 215) at 17.

[249] *See* Oliver Hart and John Moore, "Incomplete Contracts and Ownership: Some New Thoughts" (2007), 97:2 American Economic Review 182 at 183 and Michael Whinston, "On the Transaction Cost Determinants of Vertical Integration" (2003), 19:1 Journal of Law, Economics, and Organization 1 (both acknowledging that idiosyncratic relationship-specific investments are often difficult to measure empirically).

[250] *See* for example, Roddy Boyd, *Fatal Risk: A Cautionary Tale of AIG's Corporate Suicide* (Wiley, New York, 2011); Richard Square, "Shareholder Opportunism in a World of Risky Debt" (2010), 123 Harvard Law Review 1151; William Sjostrum, "The AIG Bailout" (2009), 66 Washington and Lee Law Review 943, and Congressional Oversight Panel, "The AIG Rescue, Its Impact on Markets, and the Governments Exit Strategy" (20 June 2010), available at http://www.gpo.gov.

[251] *See* Congressional Oversight Panel (n 250) at 18-36.

[252] Ibid. at 72 (identifying the derivative counterparties of AIG that ultimately received payouts from the Federal Reserve Bank of New York).

[253] Ibid. at 24.

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relevant swap contracts.[254] Eventually, the markets for these CDOs and many of the underlying assets would break down completely—thus leaving counterparties with no observable market price against which to mark their exposures or calculate variation margin requirements. As the mark-to-market losses on these contracts mounted[255], AIG suffered a series of downgrades to its own credit rating, thus triggering further collateral calls.[256] These collateral calls slowly but steadily drained AIG's cash holdings: subjecting it to a death by a thousand cuts. It was against this backdrop that an illuminating renegotiation between AIG and its counterparty Goldman Sachs unfolded.

Goldman Sachs and AIG share a long history. In the 1990s, it was reported that then Goldman CEO Jon Corzine and AIG Chairman Hank Greenberg briefly flirted with the idea of a merger between the two venerable Wall Street firms.[257] Over the years, Goldman and AIG had also worked together on a number of significant transactions.[258] Yet despite this longstanding and mutually profitable relationship, Goldman was the first counterparty to demand more collateral from AIG in response to the deterioration of the sub-prime mortgage market. On 27 July 2007, Goldman issued its first collateral call: demanding that AIG post over $USD1.8 billion in collateral.[259] Goldman would issue additional collateral calls in November 2007, and in January and March 2008.[260] Many of the valuations underpinning these collateral calls were based on actual market prices.[261] As market conditions deteriorated, however, Goldman was sometimes forced to use price changes in relation to broadly comparable assets, the movement of financial indices such as the ABX, and Goldman's own internal models as the basis for calculating the amount of variation margin that AIG was required to post.[262] By 12 September 2008, these calculations had led Goldman to request just over $USD9 billion in collateral from AIG in connection with its exposures under 33 CDS contracts providing protection against the super senior tranches of multi-sector CDOs.[263]

The negotiations between AIG and Goldman Sachs over the accuracy of Goldman's calculations—and thus the reasonableness of its collateral calls—are notable for three reasons. The first is simply their length. As described in Part III.B, the dispute resolution mechanism under a typical CSA envisions that disagreements about variation margin requirements or the value of posted collateral will be resolved no later than the

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[254] Ibid. at 28-31.

[255] Along with the losses on its related securities lending portfolio; *see* Squire (n 250).

[256] Ibid.

[257] William Cohan, *Money and Power: How Goldman Sachs Came to Rule the World* (Penguin, New York, 2011) at 383.

[258] For example, AIG and Goldman had worked together in 2003 to provide insurance on asset-backed securities issued by the private operators of two airports in Rome; John Carney, "Here's the Untold Story of How AIG Destroyed Itself", *Business Insider* (3 March 2010), available at http://www.businessinsider.com/heres-the-untold-story-of-how-aig-destroyed-itself-2010-3?IR=T.

[259] *See* collateral invoice from Goldman Sachs International to AIG Financial Products Corp dated 27 July 2007, available at https://fcic.law.stanford.edu/resource. The relevant CSA included a threshold of $USD75,000,000 and contemplated that AIG would post collateral against exposures where the price of the underlying CDOs decreased by more than 4%; *see* Financial Crisis Inquiry Commission (FCIC) Staff Memorandum (17 September 2010) at 4-5, available at https://fcic.law.stanford.edu/resource.

[260] *See* collateral invoices from Goldman Sachs International to AIG Financial Products Corp dated 23 November 2007, each available at https://fcic.law.stanford.edu/resource. *See* also FCIC, AIG/Goldman Sachs Collateral Call Timeline, available at https://fcic.law.stanford.edu/resource.

[261] For a summary of Goldman's approach to valuation in connection with the collateral calls, *see* Goldman Sachs, Valuation and Pricing Related to Initial Collateral Calls on Transactions with AIG (submitted to the FCIC on 31 August 2010) at 1-5, available at https://fcic.law.stanford.edu/resource.

[262] Ibid. at 6.

[263] FCIC, AIG/Goldman Sachs Collateral Call Timeline (n 260) at 15.

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next business day.[264] Where counterparties are unable to resolve a dispute within this timeframe, they will then generally seek quotes from several dealers.[265] Against this backdrop, what is remarkable about the negotiation between AIG and Goldman Sachs is that it went on for nearly 14 months: from 27 July 2007 to AIG's collapse on 16 September 2008. But for the intervention of the Federal Reserve Bank of New York, it is highly likely that these negotiations would have gone on even longer—or at least until AIG filed for bankruptcy.[266]

Part of the explanation for the length of these negotiations no doubt resides in the uncertainty (and resulting disagreement) surrounding the value of the underlying CDOs. The email correspondence between the two firms published by the Financial Crisis Inquiry Commission is dominated by discussions around the valuation methodology that Goldman used to determine its prices—or 'marks'—for the relevant CDOs.[267] The sheer size of the collateral calls was also highly unusual and might have necessitated a brief delay in the performance of AIG's obligations in order to enable it to secure the required collateral. At the same time, both counterparties appear to have been very much aware of the potential impact of the negotiation on both their own future relationship and their reputations in the marketplace. Joe Cassano, CEO of AIG Financial Products—the AIG subsidiary that had entered into the CDS contracts—stressed in an email to colleagues at the height of the negotiations that disputes with Goldman Sachs were "unusual"[268] and that the firm was "a business partner of ours and an important relationship".[269] Other AIG employees involved in the negotiations acknowledged the need to "manage the relationship" with Goldman.[270] Meanwhile, at least one senior executive at Goldman Sachs recognized that the size and suddenness of the collateral calls could be "embarrassing for the firm"[271]: undermining its relationship with AIG, raising questions about its valuation methodologies, and potentially signalling to other counterparties that, when the chips were down, Goldman's interests would trump those of its clients.[272] This executive urged Goldman to exercise caution, both in

[264] *See* discussion of New York law CSA, paragraph 5(i)(B), *infra* at 30. AIG and Goldman Sachs were joint Calculation Agents under the relevant CSA; *see* AIG Super Senior Credit Transactions Principal Collateral Provisions (7 December 2007) at 4, available at https://fcic.law.stanford.edu/resource.

[265] *See* New York law CSA, paragraph 5(i)(B). The CSA between AIG and Goldman Sachs contemplated the use of average mid-market quotations from five dealers (and then excluding the highest and lowest valuations). The agreement was silent on the question of what would happen if they were unable to get minimum number of dealer quotes; AIG Super Senior Credit Transactions Principal Collateral Provisions (n 264) at 4.

[266] Indeed, the parties actually entered into two additional side letters in relation to outstanding collateral calls after the Fed's intervention on 16 September 2008; *see* FCIC, AIG/Goldman Sachs Collateral Call Timeline (n 260) at 16.

[267] *See* for example, AIG emails between Joe Cassano, Andrew Forster, William Dooley, and Elias Habayeb regarding collateral calls (27 November 2007); AIG email re BET Valuation for Multi Sector CDO Book (11 January 2008); Joe Cassano email to Michael Sherwood and David Viniar (1 January 2008), and Joe Cassano email to William Dooley and Steven Bensinger (7 March 2008), all available at https://fcic.law.stanford.edu/resource. *See* also Cohan (n 257) at 577-591. It was subsequently revealed that AIG had no internal valuation methodology for pricing the relevant assets.

[268] Cohan (n 257) at 579.

[269] Ibid.

[270] *See* for example, AIG email from Alan Frost to Andrew Forster (16 August 2007), available at https://fcic.law.stanford.edu/resource.

[271] Cohan (n 257) at 577-578 (quoting Ram Sundaram, then Goldman Sachs Managing Director of Proprietary Trading).

[272] Ibid.

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terms of how it approached the negotiations with AIG and in the way it communicated with the wider marketplace.[273]

Second, over the course of the negotiations, both AIG and Goldman Sachs demonstrated a degree of flexibility in their bargaining positions. Despite its initial posturing, Goldman reduced the amount of its initial collateral call from $USD1.8 to $USD1.2 billion on 2 August 2007.[274] AIG reciprocated by posting $USD450 million in collateral pursuant to the terms of a side letter dated 10 August 2007.[275] Joe Cassano described this move as a show of "good faith", with another AIG executive explaining that it was intended "to get everyone to chill out".[276] While continuing to dispute Goldman's marks, AIG would go on to post additional collateral on a number of subsequent occasions—ultimately reaching a total of just over $USD6.8 billion as of 28 August 2008.[277] As revealed by AIG's internal correspondence, these payments were designed to buy the counterparties time to identify an effective mechanism for resolving both the current and, importantly, any *future* valuation disputes.[278]

Finally, despite the understandable stress and tension involved in negotiations of this magnitude, the behaviour of the personnel representing both AIG and Goldman reflected the expectation that the firms would continue to do business with each other going forward.[279] One AIG executive, for example, characterized the negotiations as "friendly discussions" rather than "disputed calls".[280] This points to what is perhaps the most notable aspect of the negotiations: despite the enormously high stakes, neither counterparty appears to have seriously considered threatening—let alone actually seeking—recourse to formal contractual enforcement. Nor crucially did they utilize the dispute resolution mechanism under the CSA. As described in Part III.B, this mechanism requires counterparties to resolve disputes within extremely tight and rigid timeframes. Perhaps more importantly, the use of this mechanism—and specifically obtaining quotes from other dealers—would have signalled to other market participants that there was a serious valuation dispute.[281] This behaviour almost certainly reflects the fundamental uncertainty that the parties faced in the thick of the financial crisis. Importantly, however, it is also consistent with the desire to preserve a profitable trading

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[273] Ibid.

[274] *See* FCIC, AIG/Goldman Sachs Collateral Call Timeline (n 260) at 4. These changes were largely based on concessions Goldman made in terms of how it calculated the amount of required collateral.

[275] Ibid.

[276] AIG email from Alan Frost to Andrew Forster (n 270).

[277] For an overview, *see* FCIC, AIG/Goldman Sachs Collateral Call Timeline (n 260). During this period, AIG also requested that Goldman return posted collateral on a number of occasions; ibid.

[278] *See* for example, AIG email from Alan Frost to Andrew Forster (15 August 2007), available at https://fcic.law.stanford.edu/resource ("Everyone wants [the collateral call dispute] to go away, but the primary focus [of the negotiations] is to think if we can establish a way of dealing with this if we need to *again*") [emphasis added].

[279] As you might expect, this stress and tension was often reflected in internal emails. Early on in the dispute, for example, one AIG executive complained that "[Goldman Sachs] are not budging and acting irrational"; AIG email from Tom Athan to Andrew Forster regarding HALO call (1 August 2007), available at https://fcic.law.stanford.edu/resource. Ultimately, however, the tone of these internal emails stands in stark contrast with the frank but nevertheless polite and constructive tone of the correspondence between the firms.

[280] Andrew Forster, AIG Status of Collateral Call Postings (31 December 2007) at 1, available at https://fcic.law.stanford.edu/resource. *See* also Cohan (n 257) at 581-584.

[281] *See* for example, AIG email from Joe Cassano to William Dooley and Steven Bensinger (n 267), reporting that Goldman Vice Chair Michael Sherwood thought "it would be embarrassing if we brought the market into our disagreement" by obtaining dealer quotes). The parties were also sceptical about whether they could identify a sufficient number of dealers willing and able to provide the necessary quotes.

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relationship and avoid acquiring a reputation in the marketplace as a litigious or uncooperative counterparty.

The negotiations between AIG and Goldman Sachs hold out a number of insights into the role that reputation and the expectation of future dealings can play in addressing the risks posed by incomplete contracting. Paramount amongst these insights is that these informal mechanisms can motivate counterparties to retain a degree of flexibility under circumstances where the rigid application of state-contingent terms becomes technically impossible: e.g. because there are no observable market prices. Along the same vein, these mechanisms can serve as a safety valve in circumstances where the use of other formal mechanisms would have potentially undesirable side effects: e.g. because obtained dealer quotes would reveal potentially damaging information to the marketplace. Reputation and the expectation of future dealings can thus be understood as providing the counterparties with valuable *optionality*. Whereas state-contingent contracting, property rights, and the allocation of decision-making authority may work well under normal market conditions, these informal mechanisms can thus play an important role where changes to market or counterparty credit risk are non-observable, or in the presence of fundamental uncertainty about prevailing market conditions, the value of property rights, or the impact of delegated decision-making (*see* Figure 10).

Importantly, the formal and informal mechanisms embedded within derivative contracts can also be viewed as mutually reinforcing one another. For example, how Valuation Agents approach disputed calculations can provide parties with useful information about the propensity of their counterparties to behave cooperatively (or opportunistically) in the process of resolving joint problems. Over time, a demonstrated pattern of cooperative behaviour in solving these problems can then theoretically be used to build-up a reserve of goodwill that can be tapped during periods of uncertainty. The expectation of cooperative behaviour can also induce counterparties to agree to more detailed state-contingent terms or mechanisms contemplating the allocation of property or decision-making rights at the outset of the relationship—safe in the knowledge that the prospect of opportunism will be effectively constrained by the threat of reputational sanctions and the loss of future earnings. What might initially look like a relatively straightforward state-contingent contract can thus be viewed as intricately braided with strong and yet supple relational threads.

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Figure 10

The Braiding of State-Contingent Contracting and Other Mechanisms

		Mechanism		
		State-Contingent Contracting	Formal Mechanisms	Informal Mechanisms
State of the World	No observable Δ in market/counterparty credit risk	▪ Basic payment and delivery obligations ▪ Payment netting		
	Observable Δ in market/counterparty credit risk	▪ Basic payment and delivery obligations ▪ Payment netting ▪ Margin requirements	▪ Collateral ▪ Valuation Agent	
	Non-observable Δ in market or counterparty credit risk Fundamental uncertainty	▪ Basic payment and delivery obligations ▪ Payment netting ▪ Margin requirements	▪ Collateral ▪ Valuation Agent ▪ Standards-based contracting	▪ Reputation ▪ Expectation of future dealings
	Bankruptcy of a counterparty	▪ Closeout netting	▪ Collateral	

The negotiations between AIG and Goldman Sachs also highlight the limits of these informal mechanisms. As a preliminary matter, Goldman's approach toward the negotiations may have been different had AIG not been such an important client—or if AIG had not owed Goldman so much money. More generally, contracting parties will often face powerful countervailing incentives. The use of collateral, for example, reduces *ex ante* incentives to make significant relationship-specific investments, thereby making it less likely that these relationships would be fully developed in *ex post* states of the world characterized by high levels of uncertainty. Once the counterparties were actually confronted with this uncertainty, the provision of collateral also reduced Goldman's skin in the game—and thus its motivation to work constructively toward a timely and effective resolution to the valuation dispute. Reputation and the expectation of future dealings may have also worked at cross purposes: with Goldman's desire to preserve its relationship with AIG potentially conflicting with its desire to protect its reputation in the marketplace. Specifically, whereas the desire to retain AIG as a client would have incentivized Goldman to work constructively toward the resolution of the dispute, the desire to protect its own reputation appears to have influenced its decision to initially reject one possible solution—obtaining dealer quotes—that would have revealed potentially damaging information to the marketplace. Along the same vein, Goldman's standing and relationships within the tight knit dealer community may have represented a more powerful influence on its approach toward the negotiations than its relationships with either AIG or the rest of its more widely dispersed client base.

Third, the negotiations between AIG and Goldman Sachs were fraught with asymmetries of information and bargaining power. By virtue of its privileged position as a dealer, Goldman knew far more than AIG about the prevailing market conditions

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for both CDS contracts and the underlying CDOs.[282] Goldman had also made significant investments in developing relatively robust methodologies for valuing the CDOs at the heart of the dispute.[283] Indeed, despite its strenuous and repeated objections to Goldman's valuation methodologies, it was subsequently revealed that AIG had not actually developed its own proprietary methods for valuing the securities against which it had sold credit protection.[284] The resulting asymmetries of information and expertise gave Goldman a clear advantage in the negotiations and, in theory at least, exposed AIG to some level of opportunism.

Finally, reputation and expectation of future dealings are unlikely to mitigate the risks posed by incomplete contracting where significant doubts arise regarding a counterparty's solvency. The reason for this is relatively straightforward: any increase in the probability of a party's insolvency should result in a corresponding decrease in its counterparty's expectations regarding the future revenue stream from the relationship. Where a party is not fully collateralized, any increase in the probability of a counterparty's insolvency will also result in a commensurate increase in counterparty credit risk. In this regard, it is worth noting that while Goldman was working with AIG toward a resolution of the valuation dispute, it was also purchasing billions of dollars of credit protection against the risk of AIG's default.[285] Regardless of the prevailing level of uncertainty, the threat of insolvency can thus trigger a shift away from reliance on informal mechanisms such as reputation and the expectation of future dealings and toward strict enforcement of formal contract and property rights (*see* Figure 10).

Turning these limits on their head enables us to make some tentative predictions about when these relational mechanisms are most likely to represent the binding constraints on counterparty behaviour. Perhaps most importantly, we would expect to find stronger relational elements in the context of counterparty relationships between larger firms, engaged across a number of different business lines, and with a high volume of bilateral transaction activity. This prediction is consistent with anecdotal evidence that —prior to the financial crisis—large dealers typically did not require other dealers to post collateral. As we shall see, this prediction has important implications in terms of the impact of relational mechanisms of the stability of derivatives markets.

Ultimately, of course, one might question how far we can apply the insights from this one case study to our more general understanding how derivative contracts work. AIG and Goldman Sachs are two of the world's largest and most sophisticated financial institutions. The outstanding value of their derivative contracts with each other measured in the billions of dollars. The renegotiation of these contracts took place in the midst of the largest financial crisis since the Great Depression. There are many reasons why this case study arguably stands out as a potential exception, rather than generally applicable rule. Yet this is precisely the point: how derivatives work in bad times will inevitably depend on the identity of the counterparties, the strength of their relationships, the size of their outstanding exposures, and the exigencies of the crisis.

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[282] *See* Goldman Sachs, Valuation and Pricing Related to Initial Collateral Calls on Transactions with AIG (n 261).

[283] For further details regarding these methodologies, *see* Goldman Sachs, Valuation and Pricing Related to Initial Collateral Calls on Transactions with AIG (n 261).

[284] *See* Testimony of AIG executives before the FCIC (30 June and 1 July, 2010), available at https://fcic.law.stanford.edu/resource.

[285] *See* FCIC, AIG/Goldman Sachs Collateral Call Timeline (n 260) at 2, 4-8 and 10-15 (detailing the level of Goldman's CDS protection against AIG's default between 27 July 2007 and 12 September 2008).

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For all their sophistication, derivative contracts—like most contracts—are fundamentally incomplete. While this incompleteness may be immaterial in good times, in bad times it exposes counterparties to the risk of inefficient outcomes and potential opportunism. Counterparties can employ a number of mechanisms to address these risks: ranging from formal mechanisms such as collateral, the designation of Valuation Agents, and standards-based contracting, to informal mechanisms such as reputation and the expectation of future dealings. Ultimately, however, the effectiveness of these mechanisms is subject to important limits—limits that depend on the idiosyncratic relationship between the counterparties and the unique circumstances in which they find themselves. Accordingly, while these mechanisms can help make derivative contracts more resilient in the face of uncertainty, they do not represent a complete solution to the problems of incomplete contracting.

IV. POLICY IMPLICATIONS

The process of splitting derivative contracts open reveals a complex and heterogeneous bundle of different elements. The resulting hybridity yields a number of important and timely policy insights. Two in particular stand out. First, the braiding of contract, property, decision-making rights, and relational mechanisms serves to distinguish derivatives from conventional equity and debt securities. This necessitates an examination of whether the regulatory regimes that apply to these securities are properly tailored to derivatives markets. Second, the flexibility associated with the relational mechanisms embedded within many derivative contracts represents something of a double-edged sword. On the one hand, by incentivizing cooperative problem solving and renegotiation under conditions of fundamental uncertainty, these mechanisms can play a useful role in promoting both institutional and broader financial stability. On the other hand, the widespread breakdown of these mechanisms can be a source of pronounced financial instability.

These insights raise a host of broader policy questions. Is the hybridity of derivative contracts socially desirable? If so, how can we replicate it across different market structures—and during periods of fundamental uncertainty? If not, how can we eliminate it without tearing at the fabric of derivatives markets? And more generally, is this hybridity sustainable within an increasingly large, complex, and atomized financial system? This section explores these important questions, along with their possible future implications in terms of the structure and regulation of derivatives markets.

A. The Regulation of Derivatives as Securities

The first and in many respects most straightforward question is whether derivative contracts should be regulated as securities. The definition of a "security" under section 2(a)(1) of the Securities Act of 1933[286] encompasses a diverse range of financial instruments including: conventional stocks and bonds; notes, debentures, and other evidence of indebtedness; call and put options on securities; indices of securities, and

[286] Title I of Pub. L. 73-22, 48 Stat. 74, enacted 27 May 1933, codified at 15 U.S.C. § 77a et seq.

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investment contracts.[287] This diversity obscures an important fact: one of the hallmarks of securities is that financial instruments belonging to a particular class are legally and economically identical. Each and every common share of Apple Inc. entitles a shareholder to exactly the same bundle of residual cash flow and governance rights. Every bond issued by AT&T Inc. represents a contractually enforceable promise by the same counterparty to make periodic interest payments and repay investor's principal. In the case of publicly-traded securities, conventional stock exchanges have also historically provided a form of standardized private law governing, amongst other matters, issuer disclosure obligations, the governance of listed firms, and the mechanics of buying and selling listed securities.[288] While most of this private law has now been supplanted by public regulation, the effect has nevertheless been to inject an extremely high degree of homogeneity into both publicly-traded securities and the legal and institutional environment in which they trade.[289]

This homogeneity is essential to the effectiveness of the traditional securities law strategy of subsidizing the production of information. Federal securities laws utilize two primary requirements in pursuit of this strategy. The first is the imposition of prospectus, event-driven, and continuous disclosure requirements on issuers of securities.[290] The second is the imposition of pre- and post-trade transparency requirements.[291] These transparency requirements impose an affirmative obligation on stock exchanges and other trading platforms to publicly disseminate bid, ask, and other pre-trade information.[292] They also require post-trade dissemination of price, volume, and other information in connection with executed trades.[293] These requirements are designed to enhance market transparency: ultimately with the objective of improving the process of price discovery and market efficiency.[294]

Importantly, these transparency requirements are designed to work in a world where all securities of a particular class, issued by a particular issuer, are completely

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[287] For a more detailed overview of the definition of a "security", *see* James Cox, Robert Hillman, and Donald Langevoort, *Securities Regulation: Cases and Materials*, 7th ed. (Aspen Publishers, 2013), chapter 2.

[288] *See* Jonathan Macey and Maureen O'Hara, "The Economics of Stock Exchange Listing Fees and Listing Requirements" (2002), 11 Journal of Financial Intermediation 297; Jonathan Macey and Maureen O'Hara, "Regulating Exchanges and Alternative Trading Systems: A Law and Economics Perspective" (1999), 28 Journal of Legal Studies 17, and Paul Mahoney, "The Exchange as Regulator" (1997), 83 Virginia Law Review 1453.

[289] Notably, elements of this homogeneity—and specifically the institutional environment in which trading takes place—are in the process of being eroded by the emergence of alternative trading systems as competitors to conventional stock exchanges. For an overview of these systems and their impact on the trading environment for publicly-traded equity securities, *see* Merritt Fox, Lawrence Golsten, and Gabriel Rauterberg, "The New Stock Market: Sense and Nonsense" (2015), 65 Duke Law Journal 191.

[290] *Securities Act of 1933*, ss. 5 and 10 (imposing registration and prospectus requirements) and *Securities Exchange Act of 1934*, Pub. L. 73–291, 48 Stat. 881, codified at 15 U.S.C. § 78a et seq., ss. 12, 13 and 15(d) (imposing continuous and event-driven disclosure requirements).

[291] *Securities Exchange Act of 1934*, s. 11A and Regulation National Market System, SEC Release No. 34-51808 (29 August 2005) [hereinafter, "Regulation NMS"], available at https://www.sec.gov/rules/final/34-51808.pdf.

[292] Regulation NMS, Rules 602-604 and 610. Alternative trading platforms being a notable exception, where regulatory rules contemplate the non-application or waiver of pre-trade transparency requirements in certain circumstances; *see* for example, SEC, Regulation of Exchanges and Alternative Trading Systems, 17 C.F.R. 202, 240, 242 and 249 (21 April 1999).

[293] Regulation NMS, Rules 601 and 605.

[294] For a discussion of how securities laws attempt to achieve these objectives, *see* Zohar Goshen and Gideon Parchomovsky, "The Essential Role of Securities Regulation" (2006), 55 Duke Law Journal 711 and John Coffee, "Market Failure and the Economic Case for a Mandatory Disclosure System" (1984), 70 Virginia Law Review 717.

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homogeneous. In order for trade pricing and other information to be valuable to market participants, the shares of Apple Inc. bought and sold in connection with one trade must be identical to those bought and sold in subsequent trades. If they are not, we would expect market participants to invest time and effort in understanding the differences between types of Apple shares, along with the impact of these differences from a valuation perspective. Where these differences were material, we would also expect to observe different prices for each type of share. Viewed from this perspective, the key benefit of homogeneity is that it enables market participants to decode the informational signal sent by changes in price from one trade to the next, confident that these changes do not reflect any underlying legal or economic differences between securities.

By comparison, the most important feature of derivative contracts is their inherent heterogeneity. This heterogeneity stems from two principal sources. First, despite increasing contractual standardization, the detailed state-contingent terms at the heart of derivative contracts can still vary across a number of important dimensions: from the governing law of the contract, to various elections under the schedule, to the terms of the CSA governing the amount, quality, and timing of initial and variation margin requirements.[295] The legal terms governing two ostensibly identical swaps may therefore diverge considerably in practice. Second, and perhaps more importantly, the idiosyncratic aspects of the relationship between the counterparties will inevitably introduce a degree of economic heterogeneity—even in relation to legally identical contracts. These differences stem from the creditworthiness of the counterparties, the size of their outstanding exposures to one another, the nature and scope of their existing business relationship, and their expectations regarding any future dealings.[296] Accordingly, while market participants might not care very much about the identity of the buyer when they sell 100 shares of Apple Inc., they will likely care very deeply about the identity of the counterparty with whom they enter into a 5-year total return equity swap on the very same shares.

In theory, these differences can have a significant impact on the price of a derivative contract. Where these differences are costly to observe, they will also make it very difficult for market participants to disentangle the constituent elements of price reflecting market, counterparty credit, and other risks. The resulting heterogeneity can thus introduce significant price distortions: undermining the ability of market participants to separate the informational signal associated within any price changes from the noise generated by legal and economic differences between derivative contracts.[297] These distortions can impede the process of price discovery, thereby undercutting the efficiency of derivatives markets.[298]

The heterogeneity of derivative contracts thus raises serious questions about the effectiveness of recent regulatory reforms designed to enhance the transparency of derivatives markets. In the years leading up to the global financial crisis, derivatives were largely exempt from the application of federal securities laws.[299] This laissez faire regulatory treatment arguably reflected the prevailing political climate more than any

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[295] *See* Part II.A for a description of these terms and a sense of how they can vary from contract to contract.

[296] The question of whether mandatory central clearing will help eliminate these differences is examined in Part IV.B. *See* also Awrey (n 11) at 1165-1169.

[297] Ibid. at 1125-1132 and 1156-1162.

[298] Ibid.

[299] In the United States, the disapplication of federal securities law was introduced under the Commodity Futures Modernization Act of 2000, Pub. Law No. 106-554, 114 Stat. 2763 (2000).

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consensus around whether derivatives should be regulated as securities.[300] In the wake of the crisis, however, policymakers in the United States and elsewhere have been quick to extend the reach of securities laws to derivatives markets. As described in Part II.C, this has included the introduction of trade reporting and disclosure requirements broadly similar to those imposed on conventional equity and debt securities.[301] The stated objective of these requirements is to make derivative trade pricing and other information available to the marketplace on a more timely basis in order to support the process of price discovery.[302] Ultimately, however, while these new requirements will undoubtedly serve to increase the volume of available information, the price distortions stemming from the heterogeneity of derivative contracts represent a significant obstacle to improving price discovery and market efficiency.

In addition to calling into question whether derivatives should be regulated as conventional securities, the fact that derivatives are heterogeneous debt contracts suggests that—rather than focusing narrowly on enhancing transparency—the new trade reporting and disclosure requirements should be used to aggregate and disseminate information about two far more significant and pressing species of risk. The first species includes *microprudential* risks stemming the implicit leverage embedded within derivative contracts, the liquidity risks associated with correlated collateral calls, and operational risks stemming from the failure to manage these risks effectively. These microprudential risks contributed to the collapse of both AIG and Bear Stearns.[303] They also played a significant role in the 1998 failure of hedge fund Long-Term Capital Management.[304]

The second species includes *macroprudential* risks stemming from the failure of systemically important derivatives counterparties (including clearinghouses) or the correlated withdrawal of liquidity by dealers during periods of market turmoil.[305] During the crisis, it was these macroprudential risks that motivated the federal government to rescue AIG and, through AIG, major derivatives dealers such as Goldman Sachs.[306] At present, the Dodd-Frank Act transparency requirements focus on collecting and disseminating of information—namely prices—that is essentially relevant to understanding how derivatives work in good times. The existence of these significant microprudential and macroprudential risks underscores the importance of

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[300] *See* Stout (n 12) and Romano (n 12). *See also* Sheila Bair, "Regulatory Issues Presented by the Growth of OTC Derivatives: Why Off-Exchange is No Longer Off- Limits", in Robert Klein and Jess Lederman (eds.), *The Handbook of Derivatives and Synthetics* (Irwin Professional Publishing, Chicago, 1994); Willa Gibson, "Are Swaps Agreements Securities or Futures? The Inadequacies of Applying the Traditional Regulatory Approach to OTC Derivatives Transactions" (1999), 24 Journal of Corporation Law 379; Thomas Russo and Marlisa Vinciguerra, "Financial Innovation and Uncertain Regulation: Selected Issues Regarding New Product Development" (1990), Texas Law Review 1431, and David Gilberg, "Regulation of New Financial Instruments Under the Federal Securities and Commodities Laws" (1986), 39 Vanderbilt Law Review 1599.

[301] *See* Part II.C, *infra* at 32-33.

[302] *See* Commodity Exchange Act (CEA), § 2(a)(13)(B), 7 U.S.C. § (2(a)(13)(B) (as amended by Section 727 of the Dodd-Frank Act).

[303] *See* Congressional Oversight Panel (n 250) (describing their role in the collapse of AIG) and Duffie (n 57) (describing their role in the collapse of Bear Stearns).

[304] For a detailed account of the failure of Long-Term Capital Management, see Roger Lowenstein, *When Genius Failed: The Rise and Fall of Long-Term Capital Management* (Random House, New York, 2000).

[305] Awrey (n 11) at 1162-1165.

[306] *See* Congressional Oversight Panel (n 250) at 73-77 (describing how the Federal Reserve Bank of New York purchased the CDOs underlying AIG's swap contracts with 15 major counterparties, including major derivatives dealers Goldman Sachs, Deutsche Bank, Merrill Lynch, and HSBC).

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also collecting and disseminating information that can help us better understand how derivatives markets work—and sometimes don't—in bad times.

In theory, the Dodd-Frank Act trade reporting and disclosure requirements could be used to compel SDRs to collect and share information that would assist regulators and market participants to better measure, monitor, and manage these prudential risks. Thus, for example, SDRs could be required to collect granular transaction-level data regarding the identity of counterparties, the amount and quality of posted collateral, whether collateral is posted pursuant to a title transfer or security interest system, whether counterparties can reuse or re-hypothecate collateral, the triggers and frequency of variation margin calculations, and any Thresholds or minimum transfer amounts.[307] This information could then be used to monitor the concentration of market and counterparty credit risk on the balance sheets of derivatives dealers, clearinghouses, and other major counterparties. It could also be used to better map the global network of derivative contracts, measure its interconnectedness, and identify potential weaknesses. By viewing derivatives through the prism of traditional securities regulation, we may therefore be missing out on an important opportunity to shine a light on what are ultimately the most significant risks generated by the widespread use of derivatives.

These prudential risks also raise questions about who should be responsible for the regulation and supervision of derivatives markets. The Dodd-Frank Act divides responsibility between the SEC and CFTC.[308] While the CFTC has some experience with prudential regulation and supervision by virtue of its historical oversight of futures exchanges and clearinghouses, the SEC has no significant expertise in the design or implementation of prudential rules. Indeed, the SEC's only previous prudential mandate—the ill-fated Consolidated Supervised Entities (CSE) program—was an unmitigated disaster.[309] Established in 2004, the CSE program permitted large investment banks registered with the SEC as broker-dealers to voluntarily use their own internal models to calculate their minimum regulatory capital requirements. Participating firms were then subject to consolidated prudential supervision by the SEC. The list of firms that participated in the program reads like a *Who's Who* of the financial crisis: Lehman Bros., Bear Stearns, Morgan Stanley, Merrill Lynch, and Goldman Sachs. An internal audit of the CSE program conducted following the failure of Bear Stearns concluded that "it is undisputable that the CSE program failed to carry out its mission" to monitor and respond on a timely basis to the build-up of potential prudential risks.[310] The program was unceremoniously shut down in September 2008.[311] What this example suggests is that securities regulators may not always have the institutional focus, technocratic expertise, or other resources necessary to engage in effective prudential oversight. It also suggests that, where the policy decisions of securities

[307] While the Real-Time Reporting Rule adopted under section 727 of the Dodd-Frank Act does require counterparties to inform SDRs about "whether a swap is collateralized", this binary requirement does not sufficiently capture the range of dimensions across which collateralization can vary.

[308] Regulatory responsibility is based on the distinction between "swaps" (subject to CFTC oversight), "security-based swaps" (subject to SEC oversight), and "mixed swaps" (subject to joint oversight); *see* Dodd-Frank Act, ss. 721 and 761. At the same time, federal banking regulators such as the Federal Reserve Board and Office of the Controller of the Currency maintain an important role in setting capital and margin rules for derivative counterparties that are authorized as banks.

[309] For an overview of the CSE Program, *see* SEC Office of the Inspector General*, SEC's Oversight of Bear Stearns and Related Entities: The Consolidated Supervised Entities Program*, Report No. 446-A (25 September 2008), available at https://www.sec.gov/files/446-a.pdf.

[310] SEC (n 309) at viii.

[311] *See* Stephen Labaton, "S.E.C. Concedes Oversight Flaws Fueled Collapse", *New York Times* (26 September 2008), available at http://www.nytimes.com/2008/09/27/business/27sec.html.

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regulators have a significant prudential dimension, these decisions should be subject to review by regulatory authorities with direct responsibility for—and expertise in—prudential regulation and supervision.[312]

B. The Desirability of Mandatory Central Clearing

The authors of the Dodd-Frank Act were not blind to the significant prudential risks posed by the widespread use of derivatives. Far from it. The shift toward mandatory central clearing was expressly motivated by the desire to more effectively manage counterparty credit risk within derivatives markets. This shift has led to a marked increase in the volume of trading activity routed through clearinghouses, along with the imposition of strict rules governing trade reporting, initial and variation margin requirements, and the allocation of losses amongst clearinghouses and their members. The salient question thus becomes: are these rules desirable in light of the problems posed by incomplete contracting within derivatives markets?

We have already seen how incomplete contracting can generate suboptimal outcomes in the context of bilaterally cleared derivatives markets. This risk is even more pronounced within a multilateral environment. Clearinghouses seek to strengthen the credibility of contractual commitments by interposing themselves between the original counterparties and then committing to perform their obligations in accordance with a clearly defined set of *ex ante* rules that apply to all counterparties and transactions. These rules include strict variation margin requirements and the various loss allocation and mutualization mechanisms that collectively make up a clearinghouse's default waterfall. Importantly, the execution of these rules is often highly automated. The business model of clearinghouses is thus specifically engineered to prevent counterparties from renegotiating their contracts in response to changing circumstances or in the face of fundamental uncertainty.[313] Put simply, clearinghouses are *designed* to eliminate the heterogeneous, relational elements of derivative contracts.

Yet if the rules adopted by a clearinghouse are themselves incomplete, we might predict that strict adherence to these rules will, in at least some states of the world, yield socially undesirable outcomes. Perhaps the best example of this is known as 'wrong way' risk. Wrong way risk refers to the prospect that the strict enforcement of clearinghouse rules governing variation margin requirements, contingent capital calls, or the enforced allocation of positions, for example, could undermine the liquidity or solvency of a clearing member. Where this wrong way risk results in clearing member default, the loss mutualization mechanisms employed by the clearinghouse could then become a conduit for the transmission of liquidity or solvency problems to *other* clearing members—and perhaps even the clearinghouse itself. In theory, therefore, the very same mechanisms that clearinghouses use to make contractual commitments more credible can also be viewed as binding their hands and, ultimately, as a source of contractual rigidity and potential institutional and systemic instability.

[312] In theory, this is a role that could be performed by the Financial Stability Oversight Council (FSOC). In practice, however, the FSOC does not generally deal with technical regulatory or supervisory matters. Nevertheless, one could envision a governance structure such as the one current in place in the United Kingdom: where the Financial Policy Committee of the Bank of England (the analogue of the FSOC) has the authority to direct the Financial Conduct Authority (the domestic securities regulator) in relation to the implementation of macroprudential measures; for an overview, *see* Armour et al. (n 41) at 611-612.

[313] Hart and Moore (n 186) at 128 (describing how interposing a 'middleman' between contracting parties can strengthen contractual commitments by creating an impediment to bilateral renegotiation).

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Clearinghouses employ a number of mechanisms to address these risks. One of the most important mechanisms is the authority to auction off the positions of defaulting clearing members. Once a clearinghouse decides to hold an auction, clearinghouse rules will typically impose an obligation on surviving clearing members to submit good faith bids on these positions.[314] In some cases, the clearinghouse will also open up the auction to other market participants. Where an auction fails to result in the sale of all the defaulting clearing member's positions, the clearinghouse will then often have the power to forcibly allocate the remaining positions amongst surviving clearing members at a price established by the clearinghouse.[315] These auctions can thus facilitate the orderly reallocation of risk from defaulting to surviving clearing members.[316] Perhaps more importantly, during periods of market turmoil, auctions can help subsidize the production of information about prevailing market conditions under circumstances where, as we have seen, bilaterally cleared derivative markets are prone to failure.

Clearinghouse rules also typically include mechanisms designed to alleviate the pressures associated with contractual rigidity. Two potentially important mechanisms are 'tear-up' procedures and 'variation margin gain haircuts' (VMGH). As their name implies, tear-up procedures enable a clearinghouse to terminate any outstanding derivative contracts with its clearing members. In contrast with early termination following a Termination Event or Event of Default, however, these tear-up procedures do not trigger a corresponding obligation to calculate or pay an Early Termination Amount. Instead, the counterparties—and clearinghouse—are simply released from all future obligations in connection with the terminated contracts.[317]

VMGH, meanwhile, enables a clearinghouse to reduce or extinguish its obligations to transfer collateral posted by counterparties in accordance with variation margin requirements. While counterparties will still be required to post margin, the application of VMGH contemplates that a clearinghouse can retain some percentage of this collateral for the purposes of fortifying its own balance sheet. Generally speaking, a clearinghouse will only be authorized to use tear-up procedures or VMGH *after* other mechanisms in its default waterfall have been employed to absorb losses stemming from the default of one or more clearing members. Nevertheless, these mechanisms can be viewed as important safety valves designed to prevent contractual rigidity from triggering or exacerbating institutional or systemic instability.

Viewed from this perspective, the desirability of central clearing stems at least in part from the centralization of decision-making authority during periods of market turmoil. In stark contrast with bilaterally cleared derivatives markets, this centralization enables clearinghouses to mount a coordinated response to the threat of institutional or systemic instability. This response can include the use of auctions to compel the production of trading information, thereby redistributing risk and reducing the level of uncertainty within the marketplace. It can also include the use of tear-up procedures, VMGH, or other similar mechanisms designed to relax the strict application of clearinghouse rules, thereby minimizing the potential knock-on effects of clearing

[314] Where a clearing member fails to submit a bid in good faith, the clearinghouse can then impose sanctions on that member: including by allocating any remaining positions to that clearing member after a failed auction.

[315] David Murphy, *OTC Derivatives: Bilateral Trading and Central Clearing* (Palgrave Macmillan, Basingstoke, 2013) at 198.

[316] Of course, whether this reallocation is efficient is another matter that will depend on, *inter alia*, whether the surviving clearing members are themselves facing liquidity or solvency problems.

[317] This includes any obligation to return collateral posted by the counterparties in accordance with variation margin requirements (although, simultaneously, tear-up procedures do often contemplate that the clearinghouse will be obligated to return any initial margin posted by the counterparties).

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member default. This centralization of decision-making authority can thus be understood as a potentially effective solution to many of the problems associated with incomplete contracting.

By the same token, this centralization poses two potentially significant risks. The first is the risk that a clearinghouse might inadvertently use these mechanisms in ways that actually exacerbate institutional or systemic instability. Tear-up procedures, VMGH, and the forcible allocation of positions to surviving clearing members following a failed auction, for example, all serve to redistribute risk amongst clearing members. Accordingly, each of these mechanisms is a potential source of wrong way risk. This risk will be particularly acute where clearinghouses do not possess comprehensive, real-time information about prevailing market conditions or the balance sheets of their clearing members. In short, the risk of error will be most pronounced during periods of fundamental uncertainty.

Second, and perhaps more importantly, clearinghouses can use these mechanisms to relax their own survival constraint at the expense of clearing members. The vulnerability of clearing members to this potential of conflict of interest is a function of two variables. The first variable is the *governance* model of the clearinghouse—and specifically the extent to which clearing members exercise control over the design and application of clearinghouse rules. Thus, for example, this conflict will be more pronounced where the clearinghouse is a shareholder-owned corporation than where it is a member-owned cooperative. The second variable is whether the clearinghouse faces meaningful *competition*. Specifically, where there exists little or no competition for clearing services in connection with a particular type of derivative contract, a clearinghouse is unlikely to face significant reputational sanctions or a loss of future revenue for prioritizing its own survival over that of its clearing members. Ultimately, this conflict of interest provides a compelling rationale for imposing regulatory constraints around the design and application of these mechanisms by, for example, imposing caps on the size of clearing member capital calls, tear-up procedures, or VMGH. It also suggests that it may be desirable to transfer decision-making authority over the use of these mechanisms to prudential regulatory authorities in circumstances where the stability of a clearinghouse is at stake.

C. The Promise and Peril of Distributed Ledger Technology and Smart Contracts

One of the most exciting and controversial developments in finance over the past several years has been the emergence of distributed ledger technology (DLT). A distributed ledger is a database that is shared across a network of computers, with each participant able to independently access and verify the accuracy of the database at any given moment in time.[318] All changes to the database—known as 'transactions'—are initiated by one or more participants using public/private key cryptography.[319] Once initiated, these transactions are then validated by every other network participant: thereby creating a permanent, tamper-proof, and up-to-date record of all historical

[318] Importantly, while all participants will be able to observe all transactional information within the database, this information can still be presented in a way that ensures the anonymity of participants.

[319] Public/private key cryptography (often referred to simply as 'public key' cryptography) is an electronic security protocol that involves two bits of computer code known as 'keys'. The first key is a *public* key known by all participants in the network. The second key is a *private* key known only to the owner of the information in question. Transactions are initiated using the public key to encrypt the information, which can then only be decrypted by the owner of the private key. These keys combine to make a cryptographic signature that, in effect, authorize the transaction. Within distributed ledgers, this authorization is then followed by the validation of the transaction by other participants.

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transaction activity. While Blockchain is undoubtedly the best known example of DLT, distributed ledgers can vary across a number of dimensions.[320] Most importantly for the present purposes, while distributed ledgers such as Blockchain are public (or 'permissionless') networks, it is perfectly possible to create a private (or 'permissioned') network governed by a set of rules that is agreed to by all participants.

Many of the most promising applications of DLT involve combining this technology with so-called 'smart contracts'. Smart contracts are computer protocols that are designed to execute a pre-determined action upon the occurrence of a specified future event.[321] The concept of a smart contract has been around for some time.[322] Yet it is only with the emergence of DLT that the full potential of smart contracts within the realm of finance has come into sharper focus. Specifically, insofar as smart contracts can be embedded within a distributed ledger, these protocols can theoretically be used to create entirely self-executing state-contingent contracts. Thus, for example, a smart contract could be used to capture the operational terms of a legally binding contract between two or more network participants contemplating payment by one participant in the event of a specified future contingency. The occurrence of this contingency would then automatically initiate a transaction within the distributed ledger, thereby ensuring the transfer of payment pursuant to the terms of the contract.[323]

Viewed from this perspective, the promise of combining DLT with smart contracts stems from two related sources. The first is the ability to more or less completely automate the execution, clearing, and settlement of financial transactions—from basic payments, to the purchase and sale of equity and debt securities, to the processing of lifecycle events in connection with more sophisticated financial contracts—within a fully secure and transparent network environment. The second is the ability to undertake these transactions without the involvement of conventional financial intermediaries. For these reasons, proponents of DLT and smart contracts often see them as the foundations of a new financial market infrastructure: faster, cheaper, and more reliable than the incumbent financial ecosystems that they seek to disrupt.

Perhaps not surprisingly, ISDA and other industry stakeholders have identified DLT and smart contracts as offering a potentially promising technological platform for reducing costs, minimizing operational risks, and streamlining the lifecycle of derivative contracts.[324] As a preliminary matter, the fact that DLT creates a single, immutable, and constantly updated record of all transactions eliminates the need for costly and duplicative trade reconciliation processes, along with the operational risks associated with trade confirmation backlogs.[325] This "golden record"[326] can assist counterparties

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[320] These dimensions include security features, the type of consensus mechanisms used to validate transactions, and the processes used to 'mine' the information necessary to validate transactions.

[321] Accordingly, 'smart contracts' need not necessarily represent legally binding contracts or, for that matter, be particularly smart.

[322] *See* Nick Szabo, "Smart Contracts: Building Blocks for Digital Markets", Working Paper (1996), available at http://www.alamut.com/subj/economics/nick_szabo/smartContracts.html.

[323] Of course, in order for these contracts to be self-enforcing, the assets being transferred in satisfaction of any payment obligation must themselves be embedded within the distributed ledger. These embedded assets can include crypto-currencies such as Bitcoin, along with 'digitized' versions of conventional currencies, securities, and other assets.

[324] *See* ISDA and Linklaters, "Smart Contracts and Distributed Ledger – A Legal Perspective", White Paper (August 2017) and ISDA, "The Future of Derivatives Processing and Market Infrastructure", White Paper (September 2016), both available at https://www2.isda.org.

[325] ISDA (2016) (n 324) at 23. Ultimately, of course, whether DLT can eliminate trade confirmation backlogs is also a function of a network's capacity to validate transactions in something resembling real time.

[326] Ibid.

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in better monitoring and managing their derivatives exposures, including ancillary processes such as collateral management. It can also provide regulatory authorities with a more complete and accurate picture of market structure and activity, thereby improving both microprudential and macroprudential oversight whilst simultaneously reducing the regulatory reporting burden on individual counterparties and SDRs.[327] The prospect of a single, consolidated record looks especially promising in comparison with the current state of play where transactional data is often fragmented across different markets, institutions, and jurisdictions.[328]

Perhaps even more revolutionary is the prospect that the detailed state-contingent terms at the heart of derivative contracts could be structured as smart contracts and embedded within a distributed ledger. As we have already seen, the *modus ponens* (if/then) structure of basic payment and delivery obligations renders these terms highly susceptible to being expressed in the form of executable computer code.[329] The same is true of initial and variation margin requirements. Where necessary, these smart contracts could then be linked to third party data sources—or 'oracles'—that would provide the necessary input variables: e.g. share prices, benchmark interest rates, or news that an issuer had defaulted on its corporate debt. Where changes in these input variables triggered an obligation under a smart contract, this would then automatically initiate the necessary transactions within the distributed ledger. The combination of DLT and smart contracts could thus provide the foundations for an even greater degree of automation within derivatives markets—and perhaps eventually the complete digitization of derivative contracts.[330]

Lastly, DLT and smart contracts could be used to create a new breed of crypto-clearinghouses. These clearinghouses could be structured as permissioned networks, enabling network administrators to impose participant entry requirements, ensure that participants maintain a minimum level of capital in the network, and sanction participants that violate clearinghouse rules by restricting or blocking access to the network. These technologies could then be used to automate routine transactions such as the posting and return of initial and variation margin. It could also be used to automate periodic events such as clearing member capital calls, tear-ups, VMGH, and the allocation of positions following a failed auction. While the establishment of crypto-clearinghouses would obviously run counter to the technologists' vision of a world without financial intermediaries, the benefits of using this new technology to automate the existing loss allocation and mutualization mechanisms employed by clearinghouses could ultimately be very significant.

In order to capitalize on the promise of DLT and smart contracts we would first need to address a host of practical challenges. One threshold challenge is the digitization of both derivative contracts and collateral assets for the purpose of incorporating them into a distributed ledger. This digitization would require the adoption of a standardized coding language and data reporting standards, along with unique legal entity, product, and transaction identifiers.[331] A second challenge would be how to integrate contractual terms that are not easily susceptible to being captured in the form of executable

[327] Ibid.; ISDA and Linklaters (n 324) at 3, and Katharina Pistor, "Re-Imagining Finance: The Promise of Decentralized Technologies", Concept Paper (31 July 2017) at 9 [on file with author].

[328] ISDA and Linklaters (n 324) at 4 and ISDA (n 324) at 3 and 14.

[329] ISDA 2017 at 19 ("Derivatives are fertile territory for the application of smart contracts and DLT because their main payments and deliveries are heavily dependent on conditional logic").

[330] In theory, it could provide the foundations for interoperability between clearinghouses, and perhaps even between bilaterally and centrally cleared derivatives markets.

[331] ISDA (n 324) at 16-17 and 19-20.

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computer code.[332] Important terms falling into this category include Termination Events and Events of Default, both of which contemplate some level of interpretation and optionality and, thus, human intervention.[333] More broadly, we would need to establish the precise relationship between smart contracts and the underlying legal architecture.[334] Finally, the informational benefits flowing from the adoption of DLT would ultimately hinge on the size of the relevant networks. Accordingly, where networks are fragmented along product, institutional, or jurisdictional lines, it may be difficult to extract many of the most important benefits of this new technology.

Ultimately, however, by far and away the most fundamental challenges associated with the adoption of DLT and smart contracts stem from the problems posed by incomplete contracting. There is absolutely no reason to think that the code underpinning smart contracts would be any more or less complete than the current legal architecture supporting derivatives markets. The high level of automation associated with DLT is also a potential source of both transaction-level and network-wide contractual rigidity. Thus, for example, the strict and automatic enforcement of variation margin requirements or closeout netting using smart contracts would foreclose any opportunity for the counterparties to negotiate a more efficient outcome. At the very least, this contractual incompleteness and rigidity suggests that existing mechanisms such as collateral, Valuation Agents, and broad standards can still play an important role within this new market infrastructure. More importantly, it suggests that we need to think carefully about how to build safety valves into these networks in order to prevent this incompleteness and rigidity from triggering institutional or broader systemic instability.

Computer scientists Ittay Eyal and Emin Gün Sirer, for example, have proposed a decentralized consensus mechanism—or 'escape hatch'—that would permit a quorum of network participants to temporarily delay and potentially unwind transactions within a distributed ledger.[335] This mechanism could theoretically be used to suspend the automated enforcement of contractual obligations in times of crisis. Once the crisis had passed, this mechanism could then initiate the execution of any suspended or unwound transactions. Along the same vein, one could envision giving regulatory authorities the ability to suspend the automated execution of transactions in the interests of promoting network and financial stability. While the optimal design of these safety valves is beyond the scope of this paper, one or more mechanisms would appear to be necessary in order to address the risk that incomplete contracting within a distributed ledger could become a source of financial instability.

D. The Role of Central Banks as Dealers of Last Resort

We have already seen how relational mechanisms such as reputation and the expectation of future dealings can help reduce the risks posed by incomplete contracting. We have also seen how these mechanisms can break down where parties begin to harbor doubts about the creditworthiness of their counterparties. But what happens when these doubts become more widespread? As painfully illustrated during the global financial crisis, parties will often *indiscriminately* question the creditworthiness of their counterparties during periods of widespread market turmoil and fundamental

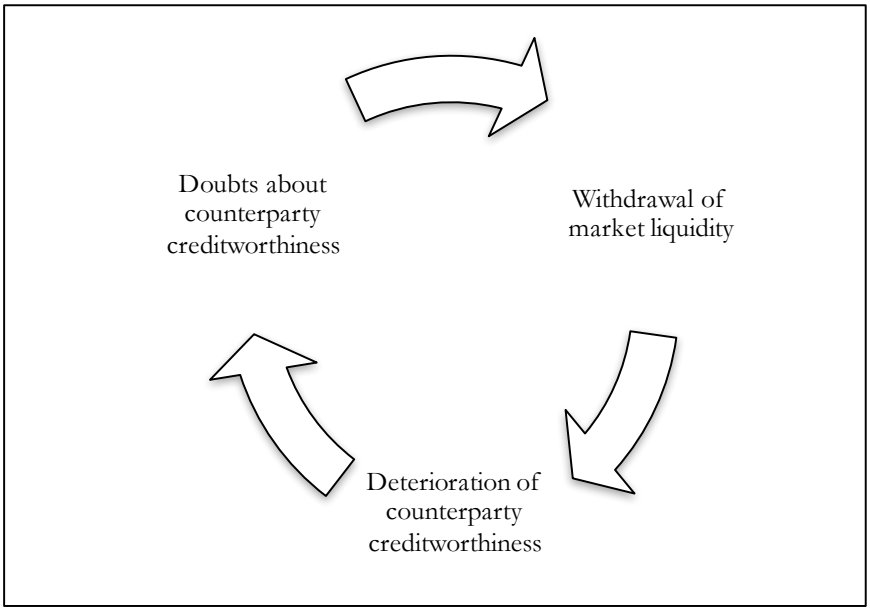
[332] ISDA (n 324) at 11-13.
[333] Ibid. at 17.
[334] *See* ibid. at 13-18 for a survey of some of the possible options in this regard.
[335] Ittay Eyal and Emin Gün Sirer, "A Decentralized Escape Hatch for DAOs" (11 July 2016), available at http://hackingdistributed.com/2016/07/11/decentralized-escape-hatches-for-smart-contracts/.

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uncertainty. These questions manifest themselves as a systemic collective action problem, triggering the withdrawal of market liquidity from short-term wholesale funding, derivatives, and other markets.[336] The existence of pervasive uncertainty can thus drive a destructive and self-reinforcing feedback loop: with doubts about the creditworthiness of counterparties translating into a correlated withdrawal of market liquidity, thereby triggering a deterioration in the creditworthiness of financial institutions that rely on these markets as a source of funding, and generating yet more uncertainty and illiquidity (*see* Figure 11).[337]

Figure 11

The Feedback Effects of Fundamental Uncertainty



The conventional prophylactic against these types of collective action problems is the extension of emergency liquidity assistance (ELA) by central banks acting in their capacity as 'lenders of last resort'.[338] In technical terms, ELA involves "the discretionary provision of liquidity to a financial institution (or the market as a whole)

[336] *See* Gary Gorton and Andrew Metrick, "Securitized Banking and the Run on Repo" (2012), 104 Journal of Financial Economics 425; Gary Gorton, "Information, Liquidity, and the (Ongoing) Panic of 2007" (2009), 99 American Economic Review 567; Gorton and Ordonez (n 48), and Robert Hockett, "Recursive Collective Action Problems: The Structure of Procyclicality in Financial and Monetary Markets, Macro-economies, and Formally Similar Contexts" (2015), 3:2 Journal of Financial Perspectives 1. Not surprisingly, dealers often play a central role in these collective action problems; *see* Paul Tucker, "Re-thinking the Lender of Last Resort", BIS Working Paper No. 79 (September 2014) at 29 ("wishing to avoid the capital strain of allowing their balance sheets to expand, dealers widen their bid-offer spreads to deter trade or, in the extreme, "don't pick up the phones" as used to be said. A collective action problem kicks in, as it is more risky to be a market-maker if you think your peers are withdrawing.").

[337] *See* Willem Buiter and Anne Sibert, "The Central Bank as the Market Maker of Last Resort: From Lender of Last Resort to Market Maker of Last Resort" (13 August 2007), available at https://voxeu.org/article/subprime-crisis-what-central-bankers-should-do-and-why.

[338] Deposit insurance is also often viewed as performing a similar role; *see* Douglas Diamond and Philip Dybvig, "Bank Runs, Deposit Insurance, and Liquidity" (1983), 91:3 Journal of Political Economy 401.

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by the central bank in reaction to an adverse shock which causes an abnormal increase in demand for liquidity which cannot be met by an alternative source."[339] This liquidity typically takes the form of short-term loans to banks and other financial institutions experiencing temporary liquidity problems.[340] These loans are secured by a pledge of eligible collateral assets, subject to a discount—or 'haircut'—designed to protect the central bank against any decrease in their market value.[341] In effect, ELA is designed to pump money into the financial system, thereby offsetting any contraction in market liquidity and signalling to bank depositors and other short-term creditors that the central bank is willing to provide whatever support is necessary in order to restore market confidence and stability. ELA facilities are thus an essential tool of financial crisis management: the last line of defence against financial panic and instability before governments are forced to resort to taxpayer-funded bailouts.

One of the first and most striking policy responses to the global financial crisis was the dramatic expansion of ELA facilities in the United States, United Kingdom, and Continental Europe. In the thick of the crisis, the Federal Reserve established a range of *ad hoc* facilities designed to provide ELA to a large cross-section of the financial system: from money market mutual funds, to primary dealers in government securities, to the triparty repo, asset-backed security, asset-backed commercial paper, and foreign exchange markets.[342] Similar facilities were established in other jurisdictions.[343] This expansion reflected the increasingly important role that markets and institutions *other than conventional deposit-taking banks* play in the allocation of capital and risk within the financial system.[344] This, in turn, raises an important question: should central banks establish standing facilities designed to provide to derivatives and other systemically important markets? Put simply: should they act as *dealers* of last resort?[345]

The key to understanding the important role that a dealer of last resort mechanism might play in a crisis resides in the unique character of central banks. Specifically, the size of central bank balance sheets, the absence of binding solvency constraints, and the legal authority to create high-powered base money makes the commitments of these institutions to perform their contractual obligations extremely credible. In sharp contrast with other market participants, counterparties are thus highly unlikely to question the creditworthiness of a central bank—even during periods of fundamental uncertainty. This makes central banks the ideal counterparty to step into the breach created by the

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[339] Xavier Freixas, Curzio Giannini, Glenn Hoggarth, and Farouk Soussa, "Lender of Last Resort: A Review of the Literature", Bank of England Financial Stability Review (1999) 151 at 152.

[340] It can also take the form of central bank purchases of (less liquid) assets in exchange for (more liquid) cash and cash equivalents that can be used to satisfy the claims of depositors and other creditors.

[341] This discount takes the form of a decrease in the amount of the loan that can be secured against any given collateral asset. Eligible collateral assets generally include commercial loans, residential and commercial mortgages, government securities, and investment grade bonds, asset-backed securities, and other fixed income instruments.

[342] For a more detailed description of these facilities, *see* Dietrich Domanski, Richhild Moessner, and William Nelson, "Central Banks as Lenders of Last Resort: Experiences During the 2007-2010 Financial Crisis and Lessons for the Future", Federal Reserve Board, Divisions of Research and Statistics and Monetary Affairs, Finance and Economics Discussion Series, Working Paper 2014-110 (May 2014) at 6-19. As Michael Bordo notes, the expansion of ELA facilities in the United States dates at least as far back as the rescue of Penn Central (and the commercial paper market) in 1970; *see* Michael Bordo, "Rules for a Lender of Last Resort: A Historical Perspective", working paper on file with author (2014) at 24.

[343] In the United Kingdom, for example, the Bank of England launched its "Special Liquidity Scheme"; see Bank of England News Release, "Special Liquidity Scheme" (21 April 2008), available at https://www.bankofengland.co.uk/-/media/boe/files/news/2008/april/special-liquidity-scheme.

[344] Buiter and Sibert (n 337).

[345] Tucker (n 336) at 28.

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withdrawal of private market liquidity: facilitating the reallocation of risk to the market participants most willing and able to bear it, ensuring the continuous availability of market prices, and overcoming potential collective action problems. Like conventional ELA facilities, dealer of last resort mechanisms would thus be designed to restore market confidence and reverse the negative feedback loop generated by fundamental uncertainty.

How might a dealer of last resort work in practice? One relatively straightforward option would be for the central bank to post continuous two-way prices—a bid and ask—on various derivative contracts in the same way as other derivative dealers. The spread between the bid and asking prices would be set to reflect the central bank's assessment of the underlying market, counterparty credit, and other risks.[346] Importantly, however, this spread would be set *outside* the spread that prevailed under normal market conditions. Thus, for example, the central bank could announce that it was willing to enter into contracts at 50 basis points outside the average bid and ask over the six month period immediately preceding the emergence of market-wide liquidity problems.[347] If the average spread over this period was 5.00% (bid) and 5.05% (ask), this would translate into an effective spread of 4.50% (bid) and 5.55% (ask). Setting the spread outside that which prevailed under normal market conditions would maximize the probability that central bank liquidity was only tapped during periods of severe market turmoil—thus ensuring that it was truly acting as a dealer of *last* resort.[348] It would also provide a powerful incentive for market participants to return to private markets as soon as possible after a crisis.

Designing an effective dealer of last resort mechanism would require central banks to address a host of other technical challenges.[349] Three in particular stand out. The first challenge would be to determine which derivatives markets should be eligible for ELA. Important factors in this determination might include the size of the relevant market, the role of systemically important financial institutions as dealers or other major counterparties, and whether the prices within the market are used as inputs in other financial products or services.[350] The comparative informational (dis)advantage of central banks in evaluating risk within a particular market may also be an important consideration.[351] On the basis of these factors, one might argue that there exists a more compelling policy rationale for extending ELA to interest rate and foreign exchange derivatives, for example, than to equity, credit, or commodity derivatives. The second challenge would be to determine which institutions should qualify as eligible counterparties. While dealers are perhaps the most obvious candidates, it may also make sense to expand eligibility to other major counterparties depending on, for example, their systemic importance or the structure of the relevant market. The third challenge is how

[346] Buiter and Sibert (n 337). As discussed in great detail below, this pricing should also theoretically reflect the fact that, unlike other counterparties, the central bank will not pose any meaningful counterparty credit risk.

[347] The suggested spread and lookback period are only for illustrative purposes: deeper questions around the optimal design of dealer of last resort mechanisms are beyond the scope of this paper.

[348] Ibid.

[349] In the United States, the creation of a dealer of last resort mechanism would also require Congress to grant the Federal Reserve additional statutory authority; *see* Charles Calomiris, Douglas-Holtz-Eakin, Glenn Hubbard, Allan Meltzer, and Hal Scott, "Establishing Credible Rules for Fed Emergency Lending" (2017), Journal of Financial Economic Policy [forthcoming] at 11.

[350] On the incorporation of these prices into other financial products and services, *see* Robert Hockett and Saule Omarova, "Systemically Significant Prices" (2016), 2 Journal of Financial Regulation 1 at 1.

[351] Tucker (n 336) at 29. The provision of ELA can thus potentially provide a signal of private information to the marketplace; ibid.

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to avoid the inevitable moral hazard and stigma problems generated by the extension of ELA. In theory, the moral hazard problems could be ameliorated by subjecting eligible counterparties to enhanced prudential regulation and supervision.[352] To avoid stigma problems, meanwhile, it may be necessary to build a temporal lag into any requirements for central banks to disclose the identity of counterparties that have benefited from ELA.[353] Ultimately, these more detailed questions about the optimal design of dealer of last resort mechanisms are beyond the scope of this paper. The key insight is simply that—where a central bank can effectively address these challenges—these mechanisms can represent a valuable weapon in their crisis management arsenal.

One might object to the creation of a dealer of last resort mechanism on a number of different grounds. Free market ideologues, for example, might object on the grounds that these mechanisms represent an unwarranted incursion by a public body into private markets. Yet this objection ignores the historical fact that no financial system of any meaningful size or complexity has survived for any length of time without a significant level of state support.[354] Given this fact, we are arguably better off designing these mechanisms in advance rather than under the crushing political, economic, and temporal pressures of an incipient crisis. A second, more nuanced, objection is that dealer of last resort mechanisms expose central banks to potentially significant market, counterparty, and reputational risks. This is undoubtedly true. Yet as observed by Willem Buiter and Anne Sibert: "without taking these risks… central banks will be financially and reputationally safe, but poor servants of the public interest."[355]

CONCLUSION

Almost four decades after first bursting onto the scene, derivatives are perhaps no longer at the cutting edge of financial innovation. Nevertheless, academic and public policy debates around derivatives continue to be plagued by misunderstandings about the legal and economic structure of derivative contracts and the important differences between these contracts and conventional equity and debt securities. This paper has sought to correct these misunderstanding by splitting derivative contracts open and examining the complex bundle of different elements that reside with them. These elements include state-contingent contracts, property and decision-making rights, and relational mechanisms. These elements work together to strengthen the credibility of the commitments underpinning derivative contracts. Some of these elements are designed to work under normal market conditions, others under conditions of fundamental uncertainty. All of these elements have limits.

Understanding derivatives as complex and heterogeneous bundles of different elements yields a number of important policy insights. The most important of these insights are that the regulatory treatment of derivatives as securities may distract attention from their significant prudential risks, that the drive toward central clearing and greater automation needs to accompanied by mechanisms designed to reduce the risks stemming from contractual incompleteness and rigidity, and that there may be an

[352] Calomiris et al. (n 349) at 11.

[353] Although these lags notably did not prevent stigma problems from arising in connection with the extension of ELA during the financial crisis.

[354] *See* for example, Robert Hockett and Saule Omarova, "The Finance Franchise" (2017), 102 Cornell Law Review 1143 (describing finance as a public-private franchise arrangement); Anna Gelpern and Erik Gerding, "Inside Safe Assets" (2016), 33 Yale Journal on Regulation 333 (n 30) (describing the role of the state in engineering 'safe' assets), and Katharina Pistor, "The Legal Theory of Finance" (2013), 41:2 Journal of Comparative Economics 315 (describing the essentially hybridity of finance).

[355] Buiter and Sibert (n 337).

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important role for central banks in providing liquidity to derivative markets during periods of fundamental uncertainty and financial instability. Having broken derivatives down into their constituent elements, we must now seek to reconstruct them on more solid foundations.

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APPENDIX A

'Good' Times	'Bad' Times
Market liquidity is sufficient to enable new information about the underlying or posted collateral to be incorporated into current market prices (informationally *efficient* markets).*	Market liquidity is not sufficient to enable new information about the underlying or posted collateral to be incorporated into current market prices (informationally *inefficient* markets).*
Prices within derivative and other credit markets reflect differences in credit risk (*separating* equilibrium).**	Prices within derivative and other credit markets do not reflect differences in credit risk (*pooling* equilibrium).**
Current market prices for the underlying or posted collateral, even when falling, are readily observable and verifiable.	Current market prices for the underlying or posted collateral are not readily observable or verifiable.

*Informational efficiency is of course a relative concept; *see* Gilson and Kraakman (n 61). Accordingly, the key variable in terms of understanding the shift from 'good' times to 'bad' times is whether there has been a pronounced decrease in informational efficiency.

**Notably, pooling equilibriums that result in the systemic underestimation of (differences in) credit risk are included in 'bad times' for these purposes. This is consistent with the observation that periods characterized by these types of equilibriums often proceed periods where markets systemically overestimate (differences in) credit risk—i.e. a panic; *see* Gorton and Metrick (n 336).

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