

Complexity as a Catalyst of Market Failure¹

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Abstract: This article examines how the complexities of modern financial markets and investment securities can trigger market failure. The article also analyzes what steps, including possible regulation, should be taken to reduce the potential for failure. Because market complexities and failures are characteristic of complexities and failures in engineering systems with nonlinear feedback, the analysis draws on the literature analyzing those systems.

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I. INTRODUCTION

In a recent article, I examined financial-market anomalies and obvious market and regulatory protections that failed, seeking insight into the subprime financial crisis and its subsequent devolution into a larger global financial crisis.³ The crisis, I argued, can be attributed in large part to three causes: conflicts, complacency, and complexity.⁴ This article focuses on the third cause, complexity.⁵

³ Steven L. Schwarcz, *Protecting Financial Markets: Lessons from the Subprime Mortgage Meltdown*, 93 MINN. L. REV. (forthcoming in issue no. 2, 2008-09). This article refers to these crises collectively as the “subprime crisis.”

⁴ Running throughout these causes is a fourth cause, cupidity; but because greed is so ingrained in human nature and so intertwined with the other causes, it adds little insight to view it separately. These causes also do not fully capture the problem of systemic risk, which can arise from a type of tragedy of the commons; because the benefits of exploiting finite capital resources accrue to individual market participants whereas the costs of exploitation, which affect the real economy, are distributed among an even wider class of persons, market participants have insufficient incentive to internalize their externalities. Steven L. Schwarcz, *Systemic Risk*, 97 GEO. L.J. 193, 206 (2008). Cf. Martin Hellwig, *Systemic Risk in the Financial Sector: An Analysis of the Subprime-Mortgage Financial Crisis* 52 (Nov. 2008 preprint of the Max Planck Institute for Research on Collective Goods, Bonn, No. 2008/43), available at www.ssrn.com/abstract=1309442 (observing that “given the complexity and the fluidity of the network of interbank relations, there is no way in which the quantitative risk model of an individual bank could satisfactorily take account of the institution’s exposure to systemic risk”). Therefore, even in a simple financial system with no conflicts, no complacency, and no greed, systemic risk is theoretically possible absent regulation to address this collective-action problem. Steven L. Schwarcz, *Understanding the ‘Subprime’ Mortgage Crisis*, forthcoming S. C. L. REV. (2009) (Keynote Address, Law Review Symposium on the Subprime Mortgage Crisis), available at http://ssrn.com/abstract_id=1288687.

⁵ Cf. *Protecting Financial Markets*, *supra* note 3, at __ (concluding that “[s]olving problems of financial complexity may well be the ultimate twenty-first century market goal”).

Complexity does not necessarily “arise for complexity’s sake, nor from a desire to obfuscate.”⁶ Rather, it arises for two reasons: in response to “demand by investors for securities that meet their investment criteria and their appetite for ever higher yields,”⁷ and in order to facilitate the transfer and trading of risk to those who prefer to hold it, promoting efficiency.⁸ For example, more complex securities can offer investors the opportunity to gain exposure to new asset types and markets—such as foreign currency, commodities, or residential mortgages—in turn enabling them to earn higher returns and more precisely hedge risk.⁹ Complex securities issued by special-purpose vehicles and backed by pools of financial assets¹⁰ also enable firms to raise low-cost financing by accessing the ultimate source of funds, the capital markets, without going through banks or other financial intermediaries.¹¹ Complexity thus can add efficiency and depth to financial markets and investments.

⁶ Peter Green & Jeremy Jennings-Mares, Letter to the Editor, *FIN. TIMES*, July 4, 2008, at 14. At the margins, however, complexity may well arise for complexity’s sake or to obfuscate. *Cf.* Jonathan C. Lipson, [cite to his new article] (arguing that complexity may be a function of deeper human attributes than merely making markets efficient, and characterizing the trend towards inefficient complexity as the problem of “transactional entropy”).

⁷ Green & Jennings-Mares, *supra* note 6.

⁸ Jennifer Bethel & Allan Ferrel, *Policy Issues Raised by Structured Products*, BROOKINGS-NOMURA PAPERS ON FIN. SERVS. 7 (2007) (explaining that structured products can promote efficiency in this way) (forthcoming). *See also* Steven L. Schwarcz, *The Alchemy of Asset Securitization*, 1 *STAN. J.L. BUS. & FIN.* 133, 134 (1994) (explaining that by separating a corporation’s liquid assets from its risks, it may obtain lower cost financing than if it were to directly issue debt or equity).

⁹ Bethel & Ferrel, *supra* note 8, at 7.

¹⁰ The term “financial assets” includes any type of asset, such as accounts receivable, rental payments, franchise payments, loans, or other rights to payment, that over a finite period of time converts into cash. Edward M. Iacobucci & Ralph A. Winter, *Asset Securitization and Asymmetric Information*, 34 *J. LEGAL STUD.* 161, 162 (2005). *Cf.* S.E.C. Rule 3a-7 (17 C.F.R. § 270.3a-7) (related definition of “Eligible Asset”).

¹¹ Steven L. Schwarcz, *Enron and the Use and Abuse of Special Purpose Entities in Corporate Structures*, 70 *U. CIN. L. REV.* 1309, 1315 (2002). Capital markets are now the nation’s and the world’s most important sources of investment financing. *See, e.g.*, McKinsey Global Institute, *Mapping the Global Capital Markets Third Annual Report* (Jan. 2007), reporting that as of the end of 2005, the value of total global financial assets, including equities, government and corporate debt securities, and bank deposits, was \$140 trillion, available at http://www.mckinsey.com/mgi/publications/third_annual_report/index.asp.

Nonetheless, complexity can also impair markets and investments in several interrelated ways. Part II.A of this article examines how complexities of the assets underlying modern investment securities and the means of originating those assets can lead to a failure of lending standards and unanticipated defaults. Complexity in this sense derives from complication, in that the intricate combining of parts increases the likelihood that failures will occur and diminishes the ability of investors and other market participants to anticipate and avoid these failures.¹² Part II.B of the article examines how complexities of the investment securities themselves can lead to a failure of investing standards and financial-market practices. Complexity in this sense derives not only from complication but also from the difficulty of valuation. Senior securities, for instance, can carry higher credit ratings than, and can be valued above, the ratings and value of their underlying assets.¹³ Complexity deriving from complication and valuation difficulty can be thought of as cognizant complexity; things are just too complex to understand.¹⁴

Part II.C of the article next examines how complexities of modern financial markets can exacerbate these failures. For example, markets consisting of securities that pool together multiple classes of assets can create a “complex system” in which price volatility and liquidity are nonlinear functions of patterns arising from the interactive behavior of many independent and constantly adapting market participants.¹⁵ This not only can produce cognizant complexity¹⁶ but also a “tight coupling” within credit markets

¹² Cf. Merriam-Webster Online, Complex, <http://www.merriam-webster.com/dictionary/complex> (last visited June 5, 2008); Merriam-Webster Online, Complicated, <http://www.merriam-webster.com/dictionary/complicated> (last visited June 5, 2008) (defining “complicated” as “consisting of parts intricately combined” or “difficult to analyze, understand, or explain”).

¹³ See *infra* note 47.

¹⁴ See *Understanding the ‘Subprime’ Mortgage Crisis*, *supra* note 4.

¹⁵ Cf. P.G. DRAZIN, *NONLINEAR SYSTEMS* 12 (1992) (observing that nonlinear systems represent “a feedback loop in which the output of an element is not proportional to its input”).

¹⁶ Cf. Jason Kravitt, *Foreword: Some Thoughts on What Has Happened to the Capital Markets and Securitization and Where Securitization is Going*, [cite], in [cite] (2008) (observing that “the more complicated a system becomes, and the more interconnected, . . . the odds of a breakdown in a portion of the system increases (because of complexity)”).

in which events tend to move rapidly into a crisis mode with little time or opportunity to intervene.¹⁷ This additional nature of complexity is temporal¹⁸; in a complex system, signals are sometimes inadvertently transmitted too quickly to control.¹⁹

Finally, Part III of the article analyzes what steps, including possible regulation, should be taken to eliminate or alleviate these failures. Because the complexities giving rise to the failures are characteristic of complexities in engineering systems with nonlinear feedback, and the failures themselves are likewise characteristic of failures in nonlinear engineering systems, the article’s analysis draws in part from the literature analyzing these systems—including the use of chaos theory and modularity to de-couple failures from systemically bringing down complex systems in ways one cannot predict *ex ante*.²⁰

II. COMPLEXITY CAN CAUSE MARKET FAILURES

This Part examines various ways in which complexity can cause market failures.

¹⁷ I thank Rick Bookstaber for introducing the term “tight coupling,” originally borrowed from engineering nomenclature, to financial markets. *See* BOOKSTABER, *infra* note 70, at 144. Tight coupling is most pronounced when markets are illiquid and market participants are highly leveraged.

¹⁸ The effects of these types of complexity (i.e., cognizant and temporal) can combine, however, such as the cognizant complexity caused by the unexpected consequences of marking to market, which (like a complex engineering system subject to nonlinear feedback effects) resulted in a downward spiral of prices when marking to market occurred in unstable markets. *See infra* notes 121-124 and accompanying text.

¹⁹ *Understanding the ‘Subprime’ Mortgage Crisis*, *supra* note 4. *Cf.* W. Brian Arthur, *Complexity and the Economy*, SCIENCE, Apr. 2, 1999, at 107 (defining economic complexity as the tendency for patterns to emerge from systems, organizations, or products with many interdependent parts or actors that would not be predicted from classical linear economic models).

²⁰ This article is not the first to draw an analogy between financial markets and nonlinear engineering systems. *Cf.* David A. Hsieh, *Chaos and Nonlinear Dynamics: Application to Financial Markets*, 46 J. FIN. 1839 (1991); BOOKSTABER, *infra* note 70 (drawing similar analogies).

A. Complexities of the Assets Underlying Investment Securities, and of the Means of Originating those Assets

The complexities of the assets underlying investment securities, and of the means of originating those assets, can lead to a failure of lending standards and unanticipated defaults. Consider first the complexities of the underlying assets, which can include mortgage loans and a wide range of other financial assets.²¹ Each type of underlying asset requires a separate approach to modeling and valuation, including estimation of default risk, interest rate risk, and prepayment risk (the risk that the borrower might prepay the loan balance at any time, thereby jeopardizing the asset's anticipated return on investment).²² To further complicate matters, prepayment risk is correlated with interest rate risk: when rates fall, borrowers are more likely to prepay; whereas when rates rise, borrowers are more likely to default.²³ These risks are also dynamic in that they fluctuate over time, and mathematical models that attempt to estimate the dynamic correlation are, at best, approximations.²⁴ Furthermore, as models become more sophisticated to take into account interest rate movements, they rely on an increasing number of assumptions and

²¹ Iacobucci & Winter, *supra* note 10, at 162.

²² THOMAS S. Y. HO & SANG BIN LEE, *THE OXFORD GUIDE TO FINANCIAL MODELING: APPLICATIONS FOR CAPITAL MARKETS, CORPORATE FINANCE, RISK MANAGEMENT, AND FINANCIAL INSTITUTIONS* 348 (2004). Some assets, such as credit card loans, are further complicated because, unlike mortgage loans, they have no fixed payment amount or amortization schedule. Borrowers may pay in full, pay a minimum payment (usually 2% of the outstanding balance), or even increase their balance up to a specified credit limit. Mark Furletti, *An Overview of Credit Card Backed Securities 2* (Dec. 2002 unpublished manuscript) (on file with author); Susan Baig, *CDO of ABS: A Primer on Performance Metrics and Test Measures*, YieldCurve.com at 4 (last visited June 12, 2008). To address these challenges, credit card securities are typically issued separately through a revolving master trust, within which several credit accounts are pooled together to allow for multiple bond issues as well as a revolving flow of receivables. *Id.*

²³ MARK ADELSON, *MBS BASICS* (Nomura Sec. Int'l 2006) (describing the property of negative convexity in mortgage-backed securities).

²⁴ Thomas S. Y. Ho & Sang Bin Lee, *The Oxford Guide to Financial Modeling: Applications for Capital Markets, Corporate Finance, Risk Management, and Financial Institutions* 29 (2004) (discussing Monte Carlo simulations, which condition prepayment risk upon hypothetical interest rate fluctuations); *Advanced Analytics v. Citigroup*, 2008 WL 2557421, 1 (describing as "complex" the computerized process used to estimate prepayment risk).

historical data which, if incorrect, will make the valuations incorrect.²⁵ When multiple asset classes underlie a given class of securities, valuation can become exponentially complicated.

In addition to complex modeling and valuation, the terms and conditions of financial assets can also be complex. In the subprime crisis, for example, loan originators made mortgage-loan products more varied and sophisticated, and offered these products to a wider range of borrowers, purportedly in order to meet market demand.²⁶ These products included terms such as adjustable rates, low-to-zero down payment requirements, interest-only payment options, and negative amortization.²⁷ Because of this complexity, some borrowers did not fully understand the risks they were incurring²⁸ and, as a result, defaulted at a much higher rate than would be predicted by the historical mortgage-loan default rates relied on by loan originators in extending credit.²⁹

The complexities of the means of originating these assets also can lead to a failure of lending standards. For example, the originate-to-distribute model of mortgage lending,³⁰ under which mortgage lenders would sell off loans as they were made,³¹ is

²⁵ ADELSON, *supra* note 23.

²⁶ Edward Vincent Murphy, *Alternative Mortgages: Risks to Consumers and Lenders in the Current Housing Cycle*, CRS Report RL33775 at 5-6 (Dec. 27, 2006), http://assets.opencrs.com/rpts/RL33775_20061227.pdf (last visited July 21, 2008).

²⁷ *Id.* at 12.

²⁸ Patricia A. McCoy & Elizabeth Renuart, *The Legal Infrastructure of Subprime and Nontraditional Home Mortgages* 19, Joint Center for Housing Studies, Harvard University, Feb. 2008, http://www.jchs.harvard.edu/publications/finance/understanding_consumer_credit/papers/ucc08-5_mccoy_renuart.pdf (last visited July 21, 2008).

²⁹ Edward Golding, Richard K. Green, & Douglas A. McManus, *Imperfect Information and the Housing Finance Crisis* 16, Joint Center for Housing Studies, Harvard University, Feb. 2008, http://www.jchs.harvard.edu/publications/finance/understanding_consumer_credit/papers/ucc08-6_golding_green_mcmanus.pdf (last visited July 21, 2008); Kurt Eggert, *Subprime Mortgage Market Turmoil: Examining the Role of Securitization*, Testimony before Senate Subcommittee on Securities, Investments and Insurance, April 17, 2007, at 4, http://banking.senate.gov/public_files/eggert.pdf (last visited July 21, 2008).

³⁰ This model is also referred to as “originate-and-distribute.”

believed to have contributed to the subprime crisis.³² Third parties—including government-sponsored enterprises such as Federal National Mortgage Association (Fannie Mae) and Federal Home Loan Mortgage Corporation (Freddie Mac), government agencies such as the Government National Mortgage Association (Ginnie Mae), and private investment banks—would purchase the loans and package them into mortgage-backed securities.³³ This “securitization” process increased the accessibility and affordability of mortgage lending by indirectly funding such lending through the capital markets.³⁴ Nonetheless, because the interests of the lenders were no longer aligned with the interests of the owners of the loans (the investors in the mortgage-backed securities effectively becoming owners of the loans³⁵), there is concern that the originate-to-distribute model fostered moral hazard on the part of the lenders,³⁶ resulting in lax lending standards.³⁷

³¹ Unlike lending practices common several decades ago, today mortgages are most often sold to third parties shortly after being written: thus, originated and then distributed. Richard J. Rosen, *The Role of Securitization in Mortgage Lending*, Federal Reserve Bank of Chicago, Nov. 2007.

³² *See, e.g.*, Gary B. Gorton, “The Panic of 2007,” NBER Working Paper 14358 (2008), at 68 (stating that the originate-to-distribute model is the “dominant explanation” for the financial panic).

³³ *Id.*

³⁴ *Id.* The capital markets are “markets where capital funds—debt and equity—are traded. Included are private placement sources of debt and equity as well as organized markets and exchanges.” JOHN DOWNES & JORDAN GOODMAN, *DICTIONARY OF FINANCE AND INVESTMENT TERMS* 59 (3d ed. 1991).

³⁵ These securities are discussed *infra* notes 37-22 and accompanying text.

³⁶ Moral hazard means, in this context, the greater tendency of people who are protected from the consequences of risky behavior to engage in such behavior. *See, e.g.*, Charles G. Hallinan, *The “Fresh Start” Policy in Consumer Bankruptcy: A Historical Inventory and an Interpretive Theory*, 21 U. RICH. L. REV. 49, 84 (1986).

³⁷ David Henry & Matthew Goldstein, *The Bear Flu: How it Spread*, BUS. WK., Jan. 7, 2008, at 30 (arguing that the distance between mortgage-loan originators and the ultimate holders of the loans encouraged lax lending); Martin Feldstein, Op-Ed, *How to Stop the Mortgage Crisis*, WALL ST. J., Mar. 7, 2008, at A15 (describing lax lending standards that gave rise to mortgages with loan-to-value ratios of nearly 100%, and citing the 1.8 million mortgages then in default). *Cf.* John C. Dugan, Comptroller of Currency, Speech given at The Annual Convention of The American Bankers Association, San Diego, Oct. 8, 2007, at 5, <http://www.occ.treas.gov/ftp/release/2007-109a.pdf> (last visited July 16, 2008) (observing that with the increasing use of the originate-to-distribute model of

An important question here is why the ultimate owners of the loans—the distributees, which in the subprime crisis were the parties buying the mortgage-backed securities³⁸—did not impose on the originator the same strict lending standards that they would otherwise observe but for the separation of origination and ownership.³⁹ There appear to be several answers, with ramifications beyond the subprime crisis. First, by separating the ultimate owners of the mortgage loans from the actual lenders, an originate-to-distribute model makes it difficult for those owners to always see the big picture.⁴⁰ Like the fable of a blind person describing an elephant by touching only a part,⁴¹ owners often focused on isolated aspects of the market. Separating the ultimate owners also can create a collective-action problem when those owners are widely dispersed.⁴² This occurred in the subprime crisis through the securitization of subprime mortgage loans, making it difficult for owners to agree on underlying lending standards as well as making it difficult to agree on loan monitoring, or “servicing,” standards.⁴³ Furthermore,

lending, lending standards shifted from evaluating the likelihood of repayment to evaluating the likelihood that the loan could be sold). [update data-cite]

³⁸ See, e.g., Richard J. Rosen, *The Role of Securitization in Mortgage Lending*, Federal Reserve Bank of Chicago, Nov. 2007 (describing the process of mortgage securitization as the sale of loans to an investor who might hold them or repackage loans into securities—which may in turn be sold or again repackaged—such that the ultimate mortgage owner is several steps removed from the borrower).

³⁹ Most investors in securities are sophisticated institutions. SEC Staff Report of the Task Force on Mortgage-Backed Securities Disclosure, *Staff Report: Enhancing Disclosure in the Mortgage Backed Securities Markets*, Jan. 2003, available at <http://www.sec.gov/news/studies/mortgagebacked.htm> (visited Feb. 23, 2008) (reporting that investors in mortgage-backed securities are “overwhelmingly institutional”).

⁴⁰ See, e.g., Telephone Interview with Alan Hirsch, Director, North Carolina Policy Office (Feb. 20, 2008) (observing that the originate-to-distribute model made the structure “so complex that no one followed the trail”); Dugan Speech, *supra* note 37 (arguing that investors were unable to fully understand the complicated securities they bought).

⁴¹ Godfrey Saxe, *The Blindmen and the Elephant*, Poem (based on a South Asian parable).

⁴² Schwarcz, *Protecting Financial Markets*, *supra* note 3, at ___.

⁴³ *Id.* See also Martin Feldstein, Op-Ed, *How to Stop the Mortgage Crisis*, WALL ST. J., Mar. 7, 2008, at A15 (explaining that the separation of borrowers from the ultimate owners of mortgages frustrated the ability to effectively service or renegotiate troubled loans).

to the extent an originate-to-distribute model reduces the size of any given owner's investment below an amount sufficient to motivate the owner to engage in due diligence and monitoring, it could induce undue reliance on rating-agency ratings.⁴⁴

The foregoing discussion focuses on complexities of the assets underlying modern securities and the means of originating those assets. The next discussion focuses on complexities of the securities backed by these assets.

B. Complexities of Modern Investment Securities

The complexities of modern investment securities can lead to a failure of investing standards and financial-market practices for several reasons: these complexities impair disclosure; they obscure the ability of market participants to see and judge consequences; and they make financial markets more susceptible to financial contagion and also more susceptible to fraud.

To provide perspective, the subprime crisis involved complex forms of mortgage-backed securities ("MBS"). In their simplest form, MBS are typically issued through special-purpose vehicles ("SPVs," sometimes called special-purpose entities, or "SPEs"), and payment on such securities derive principally or entirely from the mortgage loans owned by the SPVs. More complex forms of MBS include CDO, or "collateralized debt obligation,"⁴⁵ securities backed by—and thus whose payment derives principally or entirely from—a mixed pool of mortgage loans and other financial assets owned by SPVs⁴⁶; and ABS CDO securities backed by a mixed pool of mortgage- and other asset-backed securities. The classes, or "tranches," of these securities are typically ranked by seniority of payment priority, with the highest priority classes being called senior securities, lower priority classes usually being called mezzanine securities, and the

⁴⁴ See *infra* note XX and accompanying text.

⁴⁵ There are even more arcane variations, such as CDOs "squared" or "cubed," but they go beyond this article's analysis.

⁴⁶ Securities backed by assets *other than mortgage loans* are sometimes referred to in the securitization industry as asset-backed securities or ABS. This article will use the term

lowest-priority class, which has a residual claim against the SPV, being called the equity.⁴⁷ The senior and many of the subordinated classes of these securities are more highly rated than the quality of the underlying mortgage loans.⁴⁸

Because huge segments of modern finance in the United States and abroad continue to operate in similar ways, involving the complex issuance by SPVs of securities backed by a wide range of financial assets (such securities being called “asset-backed securities,” and the process of creating and issuing asset-backed securities being called “securitization”⁴⁹),⁵⁰ the potential of these complexities to impair disclosure, to obscure the ability of market participants to see and judge consequences, and to make financial markets more susceptible to financial contagion and fraud goes beyond mortgage-backed securities and the subprime crisis.

Complexities of Securities Can Impair Disclosure. Complexity can deprive investors and other market participants of the knowledge needed for markets to operate effectively.⁵¹ Even if all information about a complex structure is disclosed,⁵² complexity

asset-backed securities to generically mean securities backed by any types of assets, including mortgage loans.

⁴⁷ *Protecting Financial Markets*, *supra* note 3, at ___.

⁴⁸ For example, senior securities issued in a CDO transaction are usually rated AAA even if the underlying income-generating assets consist of subprime mortgages, and senior securities issued in an ABS CDO transaction are usually rated AAA even if none of the underlying securities supporting the transaction are rated that high. This is accomplished by allocating cash collections first to pay the senior classes and thereafter to pay more junior classes. In this way, the senior classes are highly overcollateralized to take into account the possibility, indeed likelihood, of delays and losses on collection. *Protecting Financial Markets*, *supra* note 3, at ___.

⁴⁹ Securitization generally means the process of turning financial assets into securities issued by an SPV. Schwarcz, *The Alchemy of Asset Securitization*, *supra* note 8, at 135.

⁵⁰ STEVEN L. SCHWARCZ, *STRUCTURED FINANCE, A GUIDE TO THE PRINCIPLES OF ASSET SECURITIZATION* §1:1 at 1-2 (3d ed. & supps. 2006) (hereinafter, “STRUCTURED FINANCE”) (discussing securitization as a dominant means of financing in the United States and abroad).

⁵¹ See generally Steven L. Schwarcz, *Rethinking the Disclosure Paradigm in a World of Complexity*, 2004 U. ILL. L. REV. 1.

⁵² Cf. Malcolm Gladwell, *Open Secrets: Enron, Intelligence, and the Perils of Too Much Information*, NEW YORKER, Jan. 8, 2007 (distinguishing between transactions that are

increases the amount of information that must be analyzed in order to value the investment. This additional analysis entails higher cost.⁵³ According to rational ignorance theory, there is a point at which the benefit obtained from additional analysis can be outweighed, or at least appear to be outweighed, by the costs of performing that analysis.⁵⁴ In the context of securities markets, this means that firms deciding whether to allocate more analyst time or hire additional experts to analyze possible investments might view the added tangible costs as outweighing the uncertain gain.⁵⁵

Prior to the subprime crisis, for example, except for anticipating quite how profoundly home prices would drop, virtually all of the risks giving rise to the collapse of the market for securities backed by subprime mortgages appear to have been disclosed.⁵⁶ Investors did not, however, appreciate these risks, in large part because the complexity of

merely “puzzles” and those that are truly “mysteries”). To the extent complexity is merely a puzzle, investment bankers theoretically could understand it. In practice, though, “[m]any investors do not possess the resources to fully analyze complicated structured products.” Kravitt, *supra* note 16, at [cite].

⁵³ Anuj K. Shah & Daniel M. Oppenheimer, *Heuristics Made Easy: An Effort-Reduction Framework*, PSYCHOL. BULL., Mar., 2006, at 207 (describing costs of information analysis as identification of relevant data, storing of that data, assessing the weight of each piece of data, integrating alternative sources of data, and parsing or analyzing the data to produce actionable information).

⁵⁴ Community Leader’s Letter, *The Theory of Rational Ignorance*, Community Leader’s Letter: Econ. Brief N. 29 (available at: <http://www.strom.clemson.edu/teams/ced/econ/8-3No29.pdf>); Schwarcz, *Rethinking the Disclosure Paradigm*, *supra* note 51, at ___ (explaining why institutional investors face declining incentives to hire experts to parse information relating to structured products as those products increase in complexity).

⁵⁵ Steven L. Schwarcz, *Disclosure’s Failure in the Subprime Crisis*, ___ UTAH L. REV. ___, ___ (2008).

⁵⁶ *But cf.* Mark Adelson & David Jacob, *ABS/MBS Litigation Outlook*, Adelson & Jacob Consulting, Nov. 19, 2007, available at: http://adelsonandjacob.com/pubs/Litigation_Outlook.pdf (arguing that “disclosure materials generally did not highlight the [aggressive marketing of] stated-income loans to W-2 wage earners [T]he changing character of the stated-income loans (i.e., more wage earners) generally was not [disclosed]. . . . Issuers routinely disclosed that they allowed exceptions to their subprime mortgage underwriting criteria. However, they did not generally indicate whether the prevalence of these exceptions was increasing during the relevant period.”).

these securities made the risks almost impossible to understand.⁵⁷ The prospectus itself in a typical offering of these securities can be hundreds of pages long.⁵⁸ Searching through this vast volume of “information” is to some extent akin to the difficulty that would be posed by searching the Internet without a search engine, such as Google, to systematically filter through and organize results.

Investment analysts thus often resort to simplifying heuristics, such as credit ratings, as substitutes for attempting to fully understand the investments being analyzed.⁵⁹ In the subprime crisis, for example,

A lot of institutional investors bought securities substantially based on their ratings [without fully understanding what they bought], in part because the market has become so complex.⁶⁰

⁵⁷ COUNTERPARTY RISK MANAGEMENT POLICY GROUP III, CONTAINING SYSTEMIC RISK: THE ROAD TO REFORM 53 (Aug. 6, 2008) (hereinafter “CRMPG III REPORT”) (observing “there is almost universal agreement that, even with optimal disclosure in the underlying documentation, the characteristics of [several classes of securities] were not fully understood by many [large integrated financial intermediaries, hedge funds, specialized financial institutions, and other] market participants”).

⁵⁸ The disclosure documents ordinarily consist of a prospectus and a prospectus supplement, each close to two-hundred pages long.

⁵⁹ Investment managers who are compensated by the number or amount of securities recommended for investment may be especially tempted to do this, particularly if the securities being recommended are of a type that others are recommending. Schwarcz, *Disclosure’s Failure*, *supra* note 55, at ___. Cf. Shah & Oppenheimer, *supra* note 53, at 207 (explaining results of behavioral psychology experiment demonstrating that individuals increasingly employ heuristics to reduce the cost of analysis when time pressures or opportunity costs are high).

⁶⁰ *Credit & Blame: How Rating Firms’ Calls Fueled Subprime Mess*, WALL ST. J., Aug. 15, 2007, at A1 (quoting a market observer). See also Alan S. Blinder, *Six Fingers of Blame in the Mortgage Mess*, N.Y. TIMES, Sept. 30, 2007, at BU 4 (arguing that mortgage-backed securities, especially CDO securities, “were probably too complex for anyone’s good”); Aaron Lucchetti, Kara Scannell & Craig Karmin, *SEC Aims to Rein In the Role of Ratings*, WALL ST. J., June 24, 2008, at C1 (observing that “The dirty secret of some bond investors is that they simply bought securities with the highest yield for a given rating, which is why they snapped up complicated securities tied to subprime mortgages”).

Although the use of heuristics might be efficient overall in certain applications, heuristic reasoning can sometimes expose analysis to bias and systematic error.⁶¹ In the context of securities disclosure, exclusive reliance on ratings ignores the additional information that is essential to a truly competitive market in financial information.⁶²

Complexities of Securities Can Obfuscate Consequences. When securities are highly complex, parties reviewing, or even structuring, the securities may not always appreciate all the consequences.⁶³ In the subprime crisis, for example, although ABS CDO transactions were backed by what appeared to be significantly diverse securities, there was an underlying correlation in the subprime mortgage loans backing many of those securities.⁶⁴ Few, not even rating agencies, saw this correlation.⁶⁵ Although in retrospect one may say the correlation should have been realized, hidden correlations are only observable when there is full appreciation of the underlying variables.

For example, during the late 1970s and early 1980s, investors failed to recognize an underlying correlation between mobile home loans and the price of oil. An oil boom in Oklahoma drew an influx of oil workers, creating the nation's fastest growing market for

⁶¹ Christine Jolls, Cass R. Sunstein, & Richard Thaler, *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471, 1777 (1998); M. GRANGER MORGAN & MAX HENRION, *UNCERTAINTY: A GUIDE TO DEALING WITH UNCERTAINTY IN QUANTITATIVE RISK AND POLICY ANALYSIS* 47 (1990).

⁶² Cf. Zohar Goshen & Gideon Parchomovsky, *The Essential Role of Securities Regulation*, 55 DUKE L.J. 711, 714 (2006) (arguing that a precise understanding of financial-market investments is essential to a truly competitive market).

⁶³ A related concern arises to the extent securities become so highly complex that, as Professor Kenneth Klee has suggested, parties sometimes have difficulty understanding their documentation. Kenneth Klee, Remarks at the International Insolvency Institute's Eighth Annual International Insolvency Conference (June 10, 2008; notes on file with author).

⁶⁴ Schwarcz, *Protecting Financial Markets*, *supra* note 3, at __.

⁶⁵ *Id.* at __. Rating agencies make their business in carefully assessing the creditworthiness of investment securities. See generally Steven L. Schwarcz, *Private Ordering of Public Markets: The Rating Agency Paradox*, 2002 U. ILLINOIS L. REV. 1.

mobile home loans. When oil prices crashed, drilling in Oklahoma ceased, resulting in massive unemployment and causing widespread defaults on the mobile home loans.⁶⁶

The loan servicing problem, discussed earlier,⁶⁷ likewise results from the complexity of securities obfuscating consequences. Parties did not anticipate that the separate allocation of cash flows deriving from principal and interest to different investor tranches of mortgage-backed securities would lead, in a default scenario, to conflicts among investors, which in turn would make servicers reluctant to exercise the discretionary judgment needed to restructure the underlying mortgage loans—since exercising any discretion might expose servicers to liability.⁶⁸

The complexities of securities also can obfuscate consequences when payoffs on the securities are linked to unrelated events. Due to nonlinearity found in complex systems, small events can cause seemingly unrelated catastrophes as when a simple clogged pressure-release valve escalated into a meltdown at the Three-Mile Island nuclear reactor.⁶⁹ Similarly in financial markets, consequences can be obfuscated when, for example, options or other derivative instruments have payoffs that are not linearly related to the prices of their underlying securities, so that information on day-to-day market movements cannot be used to predict the payoff if the market moves dramatically.⁷⁰

Finally, the complexities of securities can obfuscate consequences when trying to assess investment risk. Investment analysts may well be able to intuit this risk, but a

⁶⁶ Paul Bennett, *Effective Monetary Policy in the U.S. and Emerging Markets*, Istanbul Bilgi University, Sept. 6-8, 2006 (unpublished manuscript on file with author) (discussing that “variables” that remains unchanged for long periods can obscure correlation).

⁶⁷ See *supra* notes 268-271 and accompany text.

⁶⁸ See *supra* note 271 and accompanying text (discussing “tranche warfare”).

⁶⁹ Richard Bookstaber, *The Myth of Non Correlation*, INSTITUTIONAL INVESTOR, Sept. 2007, at 82.

⁷⁰ RICHARD BOOKSTABER, *A DEMON OF OUR OWN DESIGN: MARKETS, HEDGE FUNDS, AND THE PERILS OF FINANCIAL INNOVATION* 156 (2007). My work in this article is inspired in part by this excellent book.

firm's senior managers often want risk to be modeled and reduced to useable numbers.⁷¹ Any model, however, can be manipulated. For example, VaR, or value-at-risk, is presently the most widely-used model for reducing investment risk to a number.⁷² As the VaR model became more accepted, banks began compensating analysts not only for generating profits but also for generating profits with low risks, measured by VaR.⁷³ Analysts therefore began to refocus investment portfolios to concentrate more on securities, such as credit-defaults swaps, that generate small gains but only rarely have losses.⁷⁴ Because the likelihood of these losses was less than the risk percentages taken into account under VaR modeling—which typically excludes losses that have less than a one-percent (or, in some cases, five-percent) likelihood of occurring within the model's limited time frame—such losses were not included in the VaR computations.⁷⁵ Analysts knew but did not always make clear to senior management that in the rare cases where such losses occurred, they would be huge.⁷⁶

Complexities of Securities Can Make Financial Markets More Susceptible to Financial Contagion. The complexities of securities can make financial markets more susceptible to financial contagion. In the subprime crisis, the complexities of securities made it easier for problems with subprime mortgage-backed securities to quickly infect the securitization and other credit markets generally. Investors did not always understand how CDO and ABS CDO securities worked, and therefore were prone to rely, in their investment decisions, on the fact that tranches of those securities were rated “investment grade” by such top rating agencies as Standard & Poor's, Moody's, and Fitch.⁷⁷ When

⁷¹ Joe Nocera, *Risk Mismanagement*, N.Y. TIMES, Jan. 4, 2009 (Sunday magazine), at 24.

⁷² *Id.* at 26.

⁷³ *Id.* at 46.

⁷⁴ *Id.* For an explanation of credit-default swaps, see *infra* notes 132-135 and accompanying text.

⁷⁵ Nocera, *supra* note 71, at 46.

⁷⁶ *Id.*

⁷⁷ Investment grade technically means a rating of BBB- or better. Schwarcz, *supra* note 65, at 7. An investment-grade rating indicates that full and timely repayment on the securities should not be speculative. See *id.* at 7-8.

those investment-grade tranches later lost money,⁷⁸ the resulting uncertainty caused investors to panic, fearing that other highly-rated securities could likewise default.⁷⁹

The complexities of securities also can make market problems more contagious. In the subprime crisis, for example, payment on many mortgage-backed securities was guaranteed by “monoline” insurers, or specialized financial insurance companies that guarantee principal and interest payments to investors on certain structured-finance and municipal securities. Monoline insurers traditionally have been thinly capitalized, the justification being that they use statistical models to stress-test every potential scenario and insure only securities that pass these tests.⁸⁰ In the subprime crisis, however, monolines did not always adequately stress-test for the scenario of rapidly falling house prices, as a result of which they were weakened by having to make payments on defaulting securities far exceeding their projections. This caused some monolines to lose their rating-agency required capital cushions and, thus, their AAA ratings, which in turn caused many monoline-guaranteed securities to lose their ratings.⁸¹ Because of uncertainty as to which securities were guaranteed by monolines and the inherent complexity of the monoline statistical rating scheme, some investors avoided any types of

⁷⁸ See, e.g., Carrick Mollenkamp & Serena Ng, *Wall Street Wizardry Amplified Credit Crisis*, WALL ST. J., Dec. 27, 2007, at A1 (reporting on the downgrade of one CDO’s triple-A rated tranches to junk status).

⁷⁹ See, e.g., Mortimer B. Zuckerman, *Preventing a Panic*, U.S. NEWS & WORLD REP., Feb. 11, 2008, at 63-64 (arguing that “the credit system has been virtually frozen” because “few people even know where the liabilities and losses are concentrated”). In economic terms, this can be seen as a variant on adverse selection. Cf. Edward L. Glaeser & Hedi D. Kallal, *Thin Markets, Asymmetric Information, and Mortgage-Backed Securities*, J. FIN. INTERMEDIATION, Jan., 1997, at 64 (describing a common adverse selection problem within mortgage-backed securities: that issuers of mortgage-backed securities have greater familiarity with the product and special information regarding its quality); George A. Akerlof, *The Market for “Lemons”: Quality Uncertainty and the Market Mechanism*, 84 Q.J. ECON. 488, 488 (1970) (describing the agency costs that arise in the common situation where sellers have better information regarding the quality of a good than the buyers; and discussing that when buyers use some statistic or rating to judge quality, overall quality for goods might decline as the benefits of quality accrue to the statistical group rather than an individual seller).

⁸⁰ *A Monoline Breakdown?*, ECONOMIST, Jul 28, 2007, at 79.

⁸¹ David Enrich & Peter Eavis, *More Subprime Pain in Store—UBS Write-Downs, Insurer Downgrades Point to More Unraveling*, WALL ST. J., Jan. 31, 2008, at ___.

securities that were customarily guaranteed by monolines, even those with fundamental underlying strength.⁸²

This is well exemplified by the resulting crisis in the auction-rate-note (“ARN”) market. ARNs are long-term debt securities with short-term resetting interest rates issued by municipalities, museums, schools, and similar entities.⁸³ Many ARNs are guaranteed by monoline insurers.⁸⁴ In February 2008, however, investors were able to find few buyers for their notes because potential buyers feared that the monolines, which also were insuring large amounts of securities backed by subprime mortgages, would default. Buyers started avoiding all ARNs, even those of strong issuers.⁸⁵

The complexities of securities also can contribute to contagion insofar as securities are so specialized and sophisticated that they have no actual or active trading market. Absent market valuation, these securities are typically valued by using highly complex mathematical models, a valuation procedure sometimes called “marking to model.”⁸⁶ Like all mathematical models, the models for valuing securities are based on assumptions.⁸⁷ If these assumptions turn out to be wrong, investors may lose confidence in the securities. This occurred, for example, in the subprime crisis where the assumptions underlying mark-to-model valuation of CDO and ABS CDO securities

⁸² Aline Van Duyn & Gillian Tett, *Markets Assess the Costs of a Monoline Meltdown*, FIN. TIMES, February 20, 2008, <http://www.ft.com/cms/s/0/8d715b9e-dfe9-11dc-8073-0000779fd2ac.html> (last visited July 16, 2008).

⁸³ Liz Rappaport & Kara Scannell, *Credit Crunch: Auction-Rate Turmoil Draws Watchdogs’ Scrutiny*, WALL ST. J., at C2 (Feb. 22, 2008).

⁸⁴ Eric R. Sirri, Testimony: The State of the Bond Insurance Industry (Before the Subcommittee on Capital Markets, Insurance, and Government Sponsored Enterprises, Committee on Financial Services, U.S. House of Representatives), Feb. 14, 2008, <http://www.sec.gov/news/testimony/2008/ts021408ers.htm> (last visited July 16, 2008).

⁸⁵ *See, e.g.*, THE BOND BUYER, Feb. 21, 2008, at 4 (observing that failed auctions are “occurring in spite of the fact that the underlying credit quality of issuers remains strong”).

⁸⁶ Neil Shah, *Can Wall Street be Trusted to Value Risky CDOs?*, REUTERS, July 13, 2007, available at <http://www.reuters.com/article/reutersEdge/idUSN0929430320070713>.

⁸⁷ *Id.* (detailing comments by M.I.T. Finance Professor Andrew Lo explaining that models used to value illiquid assets can “[break] down rather dramatically during abnormal times” because the assumptions underlying the models fail).

turned out to be wrong, triggering panic among investors who did not (and, in the absence of a trading market or a reliable model, could not) know what those securities were worth.⁸⁸

Complexities of Securities Can Make Financial Markets More Susceptible to Fraud. Complexity also can facilitate fraud, especially in the case of complex asset-backed securities transactions.⁸⁹ To understand why, compare asset-backed securities with ordinary corporate debt securities, like bonds. When a company issues bonds, investors purchase the bonds based on the company's ability to repay, which turns on the company's public reputation for financial integrity and governance.⁹⁰ Although there certainly have been frauds, like Parmalat, WorldCom, and Global Crossing, where the reality belied the company's reputation,⁹¹ reputation is built up slowly and thus hard to fake. For example, a corporation's reputation for financial integrity is derived from actual earnings as reported through financial statements and corroborated by independent certified public accountants.⁹² With increased personal responsibility placed on corporate managers by the Sarbanes-Oxley Act, it is difficult, at least for public companies, to feign

⁸⁸ See, e.g., Floyd Norris, *Reading Write-Down Tea Leaves*, N.Y. TIMES, Nov. 9, 2007, at C1 (discussing the problems related to using valuation models). See generally Ingo Fender & John Kiff, *CDO rating methodology: Some thoughts on model risk and its implications*, Bank of International Settlements, Working Paper 163, Nov. 2004, available at <http://www.bis.org/publ/work163.htm> (last visited March 6, 2007) (discussing the problems associated with the valuation models used by rating agencies).

⁸⁹ See *supra* note 46 and accompanying text (defining asset-backed securities).

⁹⁰ Cf. Technical Committee of The International Organization Of Securities Commissions, *The Role of Credit Rating Agencies In Structured Finance Markets: Final Report*, at 4, May 2008, <http://www.iosco.org/library/pubdocs/pdf/IOSCOPD270.pdf> (last visited, August 8, 2008) (finding that credit rating agencies examine a firm's financial stability in determining the likelihood an issued security would be repaid); Hollis Ashbaugh-Skaife, Daniel W. Collins, & Ryan LaFond, *The Effects of Corporate Governance on Firms' Credit Ratings*, J. ACCT. & ECON. 42, 203-43 (2006) (finding that weak corporate governance results in poorer credit ratings).

⁹¹ [What about Enron? That was a hybrid, being only partly a fraud and also involving asset-backed securities. Cite-SLS]

⁹² Further, even the quality reputation of the auditing firm that verifies financial statements is widely believed to influence litigation exposure and the cost of raising capital. Inder K. Khurana & K. K. Raman, *Litigation Risk and the Financial Reporting*

financial integrity.⁹³ A corporation's reputation for governance derives from the quality of management, which is tested and built up over time by individual managers.⁹⁴ When companies lack a good public reputation, they find it difficult if not impossible to issue bonds in the capital markets.⁹⁵

The use of asset-backed securities, however, enables even companies without good public reputations to obtain capital-market financing indirectly by using their financial assets. Because asset-backed securities transactions are designed to withstand even a bankruptcy of the company, investors rely less on the company's reputation and much more on the ability of the financial assets originated by the company to repay the securities.⁹⁶ Therefore, much is done to monitor those assets.⁹⁷

Credibility of Big 4 Versus Non-Big 4 Audits: Evidence from Anglo-American Countries, 79 ACCT. R. 473, 474 (2004).

⁹³ Among other things, the Sarbanes-Oxley Act of 2002 requires corporate officers and similar managers to certify the accuracy and completeness of each annual report, and to certify that internal controls are in place such that managers and auditors are apprised of material information relating to the issuer and its subsidiaries. 69 AM. JUR. 2d *Securities Regulation* § 454 (2008).

⁹⁴ David Hirshleifer, *Managerial Reputation and Corporate Investment Decisions*, 22 FIN. MGMT. 145, 146 (explaining that investor beliefs about manager and firm reputation influence the cost of raising capital, recruiting employees, and marketing products).

⁹⁵ See *supra* note 90 (because many investors are limited to only bonds that carry investment-grade ratings, a poor reputation that results in poor credit ratings will restrict a firm's access to capital).

⁹⁶ STRUCTURED FINANCE, *supra* note 50, at §3:1.

⁹⁷ Query the extent to which the acceptability of this monitoring derived from traditional asset-backed (sometimes called asset-based) finance. To that extent, there may be a disconnect because traditional asset-backed finance dealt with collateral for loans, but the company was still important because if it went bankruptcy there would be an automatic stay and other bad consequences for the asset-backed lender. See, e.g., Steven L. Schwarcz, *The Easy Case for the Priority of Secured Claims in Bankruptcy*, 47 DUKE L. J. 425, ___ (1997) (discussing how bankruptcy impacts secured creditors). These same monitoring techniques may have carried over into bankruptcy-remote asset-backed securities transactions, such as securitization.

For example, under existing best-practice standards for monitoring,⁹⁸ one or more of the underwriters, trustees (or similar agents acting on behalf of the investors), and servicers of the asset-backed securities (hereinafter referred to as the “due-diligence parties”) will engage in the following due diligence procedures.⁹⁹

Before the asset-backed securities transaction is actually closed, the due-diligence parties typically review audited financial statements of the company certified as complying with generally accepted accounting standards. They also typically visit the company’s offices to meet with management and to discuss applicable servicing practices, collections practices, and credit underwriting practices for the financial assets. The due-diligence parties then review data provided by the company examining, among other things, a random sampling of the actual underlying financial-asset files.¹⁰⁰ They will then contact the obligors listed in the files to confirm the existence of those financial

⁹⁸ The Securities Act of 1933, 73 P.L. 22, 48 Stat. 74, codified at 15 U.S.C. §§ 77a et seq. (the “Securities Act”), imposes on underwriters civil liability for misstatements or omissions in the registration statement. Securities Act § 11(a)(5), codified at 15 U.S.C. 77k(a)(5). The statutory standard to establish due diligence defense is “that required of a prudent man in the management of his own property.” Securities Act § 11(c), codified at 15 U.S.C. 77k(c). The statutory standard was further elaborated by the SEC in Rule 176 (a multifactor test). 15 C.F.R. 230.176. *Escott v. BarChris Construction Corporation*, 283 F. Supp. 643 (S.D.N.Y. 1968), is the leading case on due diligence defense. *See, e.g.*, William K. Sjostrom, *The Due Diligence Defense Under Section 11 of the Securities Act of 1933*, 44 BRANDEIS L.J., 549 (2006).

⁹⁹ Sometimes, the due-diligence parties themselves look to independent third-party industry experts to perform a portion of this diligence on their behalf. *See, e.g.*, Robert W. Doty, *Issuer Due Diligence—Relying on Experts and Third Party Information* (presentation to California Debt & Investment Advisory Commission, 6th Annual Pre-Conference, Sep. 10, 2007), <http://www.treasurer.ca.gov/Cdiac/seminars/slides/20070910/doty.pdf> (last visited Aug. 27, 2008).

¹⁰⁰ It is usual to review only a random sampling where, as is customary, there are numerous small financial assets. Kathleen C. Engel & Patricia A. McCoy, *Turning a Blind Eye: Wall Street Finance of Predatory Lending*, 75 FORDHAM L. REV. 2039, 2083 note 214 (2007), citing Bill Shepherd, *Perils and Phantasm: The Mortgage Securitization Boom Is Threatened by Recession, Legislation and Rate Change*, INVESTMENT DEALERS DIG., Feb. 3, 2003 (observing that when subprime residential mortgage-backed securities (RMBS) underwriters examine loan files manually, normally they “don’t do due diligence on every single loan in a pool; at most, they do a random sample of, say, 3% of the loans”).

assets. Additionally, they will review the company's reports of the historical and anticipated default rates on the underlying financial assets and try to ascertain that these rates are generally within the range of rates reported publicly for defaults on these types of financial assets.¹⁰¹

On an ongoing basis after the transaction closes, the servicer will prepare periodic, usually monthly, servicer reports on the continuing performance of the financial assets. This report typically includes data regarding payments received on the financial assets, principal amounts that had defaulted, and the status of various reserves. Because the company itself or one of its affiliates usually acts as the servicer,¹⁰² the servicer report will be reviewed by one or more independent due-diligence parties, usually the trustee, who may even try to verify certain data such as checking payment receipts on the financial assets against what is being reported as collected. To the extent there are any problems in performance of the financial assets or discrepancies between reported and actual data, the company will be contacted to understand why. Significant problems or discrepancies usually will trigger a termination of the transaction.¹⁰³

These due-diligence procedures are formidable, but they are not foolproof because they do not micromanage all uses and sources of cash and also because, as mentioned, the servicer is not usually independent of the company.¹⁰⁴ In the recent Student Finance Corporation ("SFC") fraud, for example, to disguise very high default rates on financial assets consisting of tuition-payment loans, SFC itself made payments on those loans from the proceeds of new securitization transactions—in effect, engaging in an undisclosed Ponzi scheme.¹⁰⁵ All of the due-diligence procedures described above

¹⁰¹ [cite]

¹⁰² Cf. STRUCTURED FINANCE, *supra* note 50, §4:5 at 4-10 (observing that companies usually perform their own servicing in asset-backed securities transactions because of the cost of delegating servicing responsibility).

¹⁰³ [cite]

¹⁰⁴ See *supra* notes 101-103 and accompanying text.

¹⁰⁵ *In re Commer. Money Ctr., Inc. Equip. Lease Litig.*, 2006 U.S. Dist. LEXIS 21392 at 31-32 (N.D. Ohio, April 20, 2006), citing *MBIA Ins. Corp. v. Royal Indem. Co.*, 286 F. Supp. 2d 347, 349-55 (D. Del. 2003).

had been performed, yet the fraud remained undiscovered for years.¹⁰⁶ In another recent fraud where (again) these due-diligence procedures had been performed, the company is alleged to have misled the due-diligence parties and investors by depositing money into the collection account on the monthly date that collections were actually tested and then withdrawing the money the day after.¹⁰⁷ Existing best-practice monitoring standards thus imperfectly protect investors from fraud.

The foregoing discussion has focused on failures resulting from the complexities of modern securities and their underlying assets. This article next discusses how the complexities of modern financial markets themselves can exacerbate these failures.

C. Complexities of Modern Financial Markets

The complexities of modern financial markets can aggravate the failures discussed above, in part because of the information uncertainty and the high sensitivity of markets to information. Financial markets rely critically on the supply of liquidity in the form of credit.¹⁰⁸ The ability to contract for credit, in turn, depends on information not only about the economic health of the party seeking credit and its ability to repay (“counterparty risk”) but also about how the structure of the credit transaction more generally exposes the parties to risk.¹⁰⁹

One way in which markets per se create information uncertainty is the “indirect-holding system” under which virtually all debt and equity securities are presently traded, with intermediary entities holding securities on behalf of investors. Issuers of the securities generally record ownership as belonging to one or depository intermediaries, which in turn record the identities of other intermediaries, such as brokerage firms or banks, that buy interests in the securities. Those other intermediaries, in turn, record the

¹⁰⁶ MBIA Ins. Corp. v. Royal Indem. Co., 286 F. Supp. 2d 347, 348, 350-51 (D. Del. 2003).

¹⁰⁷ [cite to 7859]

¹⁰⁸ JOSEPH E. STIGLITZ & BRUCE GREENWALD, TOWARDS A NEW PARADIGM IN MONETARY ECONOMICS 142 (2003); MEIR KOHN, FINANCIAL INSTITUTIONS AND MARKETS 727 (1994).

identities of investors that buy interests in the intermediaries' interests.¹¹⁰ This seemingly convoluted system has decisive advantages over a direct-holding system for securities: it reduces the costs of record-keeping and lowers the risk of loss occasioned by physically transferring securities.¹¹¹ Inadvertently, however, the indirect-holding system exacerbates uncertainty by reducing transparency: third parties cannot readily determine who ultimately owns, and thus has credit exposure to, specific securities because there is no single location from which third parties can easily get that information.¹¹²

Furthermore, investors and other market participants often apply highly sophisticated mathematical techniques to attempt to quantify market information. Although this often can increase investment precision, it sometimes can backfire. Professors Khandani and Lo have hypothesized, for example, that the subprime crisis resulted, at least in part, from a convergence in hedge-fund quantitatively-constructed investment strategies. They argue that when a number of hedge funds experienced unprecedented losses during the week of August 6, 2007, the hedge funds rapidly unwound sizable portfolios, likely based on a multi-strategy fund or proprietary-trading desk.¹¹³ This unanticipated correlation of initial losses¹¹⁴ then caused further losses by triggering stop/loss and de-leveraging policies.¹¹⁵

Regardless of the extent that the subprime crisis might have resulted from a convergence in quantitatively-constructed investment strategies, the very existence of these strategies points out a broader potential to aggravate failure: that investments in financial markets are so tied to mathematical strategies that particular events can formulaically trigger massive sell-offs without parties having the time or opportunity to

¹⁰⁹ STIGLITZ & GREENWALD, *supra* note 108, at 142.

¹¹⁰ See Steven L. Schwarcz, *Intermediary Risk in a Global Economy*, 50 DUKE L.J. 1541, 1547-48 (2001).

¹¹¹ *Id.* at 1549.

¹¹² *Id.* at 1583.

¹¹³ Amir Khandani & Andrew W. Lo, "What Happened to the Quants in August 2007" (Sept. 20, 2007) (SSRN working paper no. 1015987).

¹¹⁴ [tie to discussion elsewhere of correlation-cite]

¹¹⁵ Khandani & Lo, *supra* note 113.

exercise judgment. This tight coupling of financial markets is itself a serious risk factor.¹¹⁶

Information uncertainty, whatever its source, is especially dangerous when combined with nonlinear feedback effects and tight coupling¹¹⁷—a combination which inadvertently can be created or exacerbated by regulation.¹¹⁸ This is perhaps best exemplified by mark-to-market, or “fair value,” accounting. In its simplest form, this is the common regulatory requirement¹¹⁹ that a securities account be adjusted in response to a change in the market value of the securities. An investor, for example, may buy securities on credit from a securities broker-dealer, securing the purchase price by pledging the securities as collateral. To guard against the price of the securities falling to the point where their value as collateral is insufficient to repay the purchase price, the broker-dealer requires the investor to maintain a minimum collateral value. If the market value of the securities falls below this minimum, the broker-dealer will issue a “margin call” requiring the investor to deposit additional collateral, usually in the form of money or additional securities, to satisfy this minimum. Failure to do so triggers a default, enabling the broker-dealer to foreclose on the collateral.¹²⁰

¹¹⁶ See *supra* note 17 and accompanying text.

¹¹⁷ Nonlinearity results when “interactions among components of a system are not directly proportional.” Virginia R. Burkett et al., *Nonlinear Dynamics in Ecosystem Response to Climactic Change: Case Studies and Policy Implications*, 2 J. ECOLOGICAL COMPLEXITY 357, 359 (2005).

¹¹⁸ BOOKSTABER, *supra* note 70, at 146 (observing that “the natural reaction to [financial] market breakdown is to add layers of protection and regulation. But trying to regulate a market entangled by complexity can lead to unintended consequences, compounding crises rather than extinguishing them because the safeguards add even more complexity, which in turn feeds more failure.”).

¹¹⁹ Accounting rules are a form of regulation, being promulgated (in the United States) by the Financial Accounting Standards Board pursuant to its delegation of authority from the Securities and Exchange Commission. FINANCIAL ACCOUNTING STANDARDS BOARD, *FACTS ABOUT FASB* (2002), at 1, *available at* http://www.fasb.org/facts/facts_about_fasb.pdf (discussing this delegation of regulatory authority).

¹²⁰ ZVI BODIE, ALEX KANE & ALAN J. MARCUS, *INVESTMENTS* 78-79 (7th ed. 2008).

Requiring investors to “mark to market” in this fashion is generally believed to reduce risk.¹²¹ Nonetheless, it can cause “perverse effects on systemic stability” during times of market turbulence, when forcing sales of assets to meet margin calls can depress asset prices, requiring more forced sales (which, in turn, will depress asset prices even more), causing a downward spiral.¹²² The existence of leverage makes this spiral more likely and amplifies it if it occurs.¹²³ At least some portion of the subprime crisis appears to have been caused by this downward spiral.¹²⁴

Another way that the complexities of modern financial markets can aggravate failures is through human interactive behavior. When financial markets exhibit properties of a complex system, the ability to predict consequences, such as cause-and-effect explanations for market movements, is frustrated by nonlinear feedback effects arising from interactivities among market participants.¹²⁵ For example, just a few years ago, home prices were described as overinflated in many markets due partially to lax lending

¹²¹ See, e.g., Gikas A. Hardouvelis & Panayiotis Theodossiou, *The Asymmetric Relationship Between Initial Margin Requirements and Stock Market Volatility Across Bull and Bear Markets*, 15 REV. FIN. STUD. 1525, 1554–55 (2002) (finding a correlation between higher margin calls and decreased systemic risk, and speculating that higher margin calls may bleed the irrationality out of the market until only sound bets are left).

¹²² Rodrigo Cifuentes, Gianluigi Ferrucci, & Hyun Song Shin, *Liquidity Risk and Contagion 2* (working paper, Jan. 19, 2004, on file with author). See also Clifford De Souza & Mikhail Smirnov, *Dynamic Leverage: A Contingent Claims Approach to Leverage for Capital Conservation*, J. Portfolio Mgmt., Fall 2004, at 25, 28 (arguing that, in a bad market, short-term pressure to sell assets to raise cash for margin calls can lead to further mark-to-market losses for remaining assets, which triggers a whole new wave of selling, the process repeating itself until markets improve or the firm is wiped out; and referring to this process as a Critical Liquidation Cycle).

¹²³ *Id.* at 26-27.

¹²⁴ Rachel Evans, *Banks Tell of Downward Spiral*, 27 INT’L FIN. L. REV. (June 2008), at 16.

¹²⁵ See NEIL F. JOHNSON, PAUL JEFFERIES, & PAK MING HUI, FINANCIAL MARKET COMPLEXITY 4 (2003) (also describing this as the difficulty of distinguishing exogenous from endogenous factors); Thomas Lee Hazen, *The Short-Term/Long-Term Dichotomy and Investment Theory: Implications for Securities Market Regulation and for Corporate Law*, 70 N.C. L. REV. 137, 157 (1991) (observing that irrational investor behavior that interferes with market efficiency is sometimes referred to as “noise”). Cf. BOOKSTABER, *supra* note 70, at 156 (observing that when market participants have a self-interest in gaming the system, it is all the more likely that an unanticipated crisis will arise).

standards that artificially fuelled demand for higher priced homes.¹²⁶ At the same time, credit became increasingly available to less creditworthy borrowers as investors sought higher rates—arguably expecting home prices to continue to rise unabated.¹²⁷ The increasing availability of credit overinflated home prices even more, causing a greater-than-expected decline when the bubble burst.¹²⁸ In turn, this greater-than-expected decline in home prices not only caused mortgage owners to suffer higher-than-expected losses but also increased the rate of foreclosure, which itself further depressed home prices (causing mortgage owners to suffer even more).¹²⁹

Another example of this nonlinear feedback effect is caused by the interactive nature of securities trading. Modern financial markets often feature quickly-adapting participants trading in sophisticated securities. This can frustrate stability, however—resulting in positive feedback loops and a failure of arbitrage price correction—when participants trade as much in reaction to the expected behavior and strategy of others as on their own information and analysis.¹³⁰ An extreme form of this phenomenon can occur

¹²⁶ Ted Cornwell, *Merrill Lynch Sees Credit Concerns Persisting in Mortgage Arena*, NAT'L MORTGAGE NEWS, May 30, 2005, at 15 (describing comments by Merrill Lynch analyst Kenneth Bruce that mortgage borrowers were “overleveraged” and that “creative financing” was driving overinflated home prices).

¹²⁷ Tom Petruno, *Cheap Loans are Under Fire: Mortgage Companies Are on the Defensive for Loosening Credit Standards Amid the Housing Boom*, L.A. TIMES, Sept. 18, 2005, at C1 (explaining that mortgage lenders continued to loosen credit standards to insure fee income and higher rates amid Fed rate hikes and skyrocketing home prices). *See also*, David Streitfeld, *It's Not a Bubble Until it Bursts: Although Ignoring Real Estate Bears Has Been Profitable Lately, Doom is Again on Some Lips*, L.A. TIMES, May 29, 2005 (describing participants in real estate markets as making investment decisions based primarily on their predictions of the behavior of other participants—namely mortgage lenders and home buyers).

¹²⁸ *The Fed's Alibi*, WALL ST. J., Sept. 17, 2007, at A16 (arguing that the “Fed’s easy money policies helped cause the housing bubble and subprime crisis”).

¹²⁹ Justin Lahart, *Ahead of the Tape*, WALL ST. J., Aug. 22, 2007, at C1 (observing that a dramatic tightening of standards by purchasers in the secondary mortgage market, after “rising default rates[,] led to steep losses” to mortgage owners).

¹³⁰ *See supra* note 15 and accompanying text (noting that volatility and illiquidity can result from interactive behavior within markets). *See also* Lisa R. Anderson & Charles A. Holt, *Information Cascades in the Laboratory*, AM. ECON. REV., Dec. 1997, at 847 (describing experimental results involving an “information cascade” in which it is more “rational” for an individual to follow the decisions of others than to act on private

when investors make their investment decisions by anticipating what other investors will do.¹³¹

Finally, the complexities of modern financial markets can aggravate failures through the interconnectedness of market participants. Financial institutions are often connected with one another through—and in that capacity, are characterized as “counterparties” to—derivatives contracts.¹³² These financial instruments, most notably credit-default swaps (CDS),¹³³ are used by institutions to hedge against the risk on their own investments.¹³⁴ Institutions sometimes also use them to earn fees for ensuring risk on

information and analysis; this information cascade continues until some later player recognizes what has happened and deviates); Erik F. Gerding, *Laws Against Bubbles: An Experimental-Asset-Market Approach to Financial Regulation*, 2007 WIS. L. REV. 977, 984 (arguing that experimental asset markets are effective tools to evaluate the effectiveness of laws designed to limit market imperfections such as asset price bubbles in the context of complex adaptive markets); Schwarcz, *Rethinking the Disclosure Paradigm*, *supra* note 51, at 4-5 (explaining that fund managers might still trade with an irrational herd rather than seizing the arbitrage opportunity because managers face greater scrutiny for betting against a herd, have finite employment horizons, and have investment expertise that rapidly depreciates in evolving financial markets).

¹³¹ See, e.g., James Surowiecki, *Everyone’s Watching*, NEW YORKER, Nov. 10, 2008, at 35 (observing that, “in an environment of profound uncertainty [as has happened in the subprime crisis], investors have a natural if troubling tendency to turn to [futures markets for, and foreign markets in, the same types of securities] as horoscopes,” thereby turning “investing [into] an exercise in anticipating what other investors will do”; and also arguing that this tendency “can easily lead to contagion [because] selling in one market triggers selling in the next”).

¹³² PHELIM P. BOYLE & FEIDLIM BOYLE, DERIVATIVES: THE TOOLS THAT CHANGED FINANCE 7 (2001) (defining parties to a contract, especially a derivatives contract, as counterparties).

¹³³ In a credit-default swap, one party (the credit “seller”) agrees, in exchange for the payment to it of a fee by a second party (the credit “buyer”), to assume the credit risk of certain debt obligations of a specified borrower or other obligor. If a “credit event” (for example, default or bankruptcy) occurs in respect of that obligor, the credit seller will either (a) pay the credit buyer an amount calculated by reference to post-default value of the debt obligations or (b) buy the debt obligations (or other eligible debt obligations of the obligor) for their full face value from the credit buyer. STRUCTURED FINANCE, *supra* note 50, §10:3.1.

¹³⁴ Frank Packer & Haibin Zhu, Bank for International Settlements, *Contractual Terms and CDS Pricing*, BIS QUARTERLY REV. 89 (March 2005).

another party's investments.¹³⁵ Because of these interconnecting contracts, bankruptcy or other failure of a given market participant can cause that participant to default on its obligations to other market participants, who in turn—if the obligations in default are large enough—might default on their own obligations to market participants, leading to a domino-effect collapse.¹³⁶ Counterparty risk—essentially an information failure caused by lack of transparency as to counterparty financial condition—is further complicated by the lack of a formal trading system for these types of derivatives, which are simply contracts between private parties.¹³⁷ The inability of market participants to know how much contingent exposure another participant might have on these contracts increases the uncertainty.

These risks came to a head with the recent Federal Reserve bailouts of Bear Stearns and AIG. Bear Stearns, for example, had a subsidiary hedge fund which was believed to hold a large mortgage-backed securities portfolio of uncertain value.¹³⁸ At the same time, that subsidiary appeared to have significant exposure to other market participants on CDS contracts.¹³⁹ The fear was that the subsidiary's assets would be

¹³⁵ Well over 90% of derivatives contracts are currently credit-default swaps. *See, e.g.*, Comptroller of the Currency, *OCC's Quarterly Reports on Bank Derivatives Activities*, covering 1995-2008, available at <http://www.occ.treas.gov/deriv/deriv.htm> (last visited Aug. 27, 2008).

¹³⁶ *Systemic Risk*, *supra* note 4, at 198-200.

¹³⁷ CDS transactions are presently “over the counter,” meaning they are entered into contractually and not on an exchange.

¹³⁸ *See, e.g.*, *Turmoil in U.S. Credit Markets: Examining the Recent Actions of Federal Financial Regulators, Panel I of the hearing of the Senate Banking, Housing, and Urban Affairs Committee*, Federal News Service, April 3, 2008 (Statement of Sen. Charles Schumer (D-NY) that one of the reasons for Bear Stearns' failure was that “[t]wo of [Bear Stearns'] hedge funds went under due to mortgages in the summer”).

¹³⁹ *Cf.* Testimony of Ben Bernanke, Federal Reserve Chairman, before the House Financial Services Committee, *Transcript of the Semiannual Humphrey Hawkins Hearing on Monetary Policy of the House Financial Services Committee*, Federal News Service, July 16, 2008 (“Part of the reason that it was a big concern to us when Bear Stearns came to the brink of failure was that we were concerned that there were various markets where the failure of a major counterparty would have created enormous strains to the financial system”).

insufficient to pay its liabilities on the CDS contracts.¹⁴⁰ Counterparty risk is also believed to be integral to the failure of credit markets in the subprime crisis.¹⁴¹

The article next examines how failures resulting from complexity should be addressed.

III. ADDRESSING MARKET FAILURES RESULTING FROM COMPLEXITY

Complexity can add great efficiency and depth to financial markets, but it also can impair those markets by imposing high agency costs, increasing information asymmetries, and facilitating financial contagion. These failures, however, are more broadly driven by uncertainty, nonlinear feedback, and tight coupling that result in sudden, “unexpected,” and dramatic market changes, and misalignment of interests and incentives among market participants. These failures are similar to those that engineers have long faced when working with complex systems that have nonlinear feedback

¹⁴⁰ David Henry, *Wall Street’s Perfect Storm; Investors deal with a Lehman bankruptcy, the sale of Merrill Lynch to BofA, and a possible AIG restructuring*, BUS. WK, September 15, 2008, at [cite] (“[Treasury Secretary Paulson and Federal Reserve Chairman Bernanke] feared permitting Bear Stearns’ bankruptcy would throw Wall Street into chaos because Bear had untold credit derivatives contracts in place with countless other banks and hedge funds”). Netting and, to a growing extent, collateral agreements are used to mitigate counterparty credit risks. Committee on Payment and Settlement Systems and the Euro-Currency Standing Committee of the Central Banks of the Group of Ten Countries, Bank of International Settlements, *Report on OTC Derivatives: Settlement Procedures and Counterparty Risk Management*, CGFS Publications No. 8, at 1 (Sep. 1998), available at <http://www.bis.org/publ/ecsc08.htm> (last visited Nov. 7, 2008). In the United States, recent bankruptcy law changes are intended to further mitigate this risk by preventing an institution from “cherry-picking” favorable contracts with its derivatives counterparties. Edward R. Morrison & Joerg Riegel, *Financial Contracts and the New Bankruptcy Code: Insulating Markets from Bankrupt Debtors and Bankruptcy Judges*, 13 AM. BANKR. INST. L. REV. 641, 642 (2005). These bankruptcy law changes, which apply to derivatives contracts, modify § 365 of U.S. bankruptcy law under which entities in bankruptcy generally have the right to choose to continue with profitable contracts while terminating unprofitable contracts with the same counterparty. Morrison & Riegel, *supra* at 642, 647, 660, & 663.

¹⁴¹ *Understanding the ‘Subprime’ Mortgage Crisis*, *supra* note 4.

effects.¹⁴² Moreover, many characteristics of complex engineering systems are similar to those of financial systems.¹⁴³ For these reasons, this article will take into account, among other things, the “chaos theory” that helps to inform engineers about complex systems with nonlinear feedback effects.¹⁴⁴

¹⁴² The author makes this observation not only based on his experience and expertise as a finance lawyer and professor but also as a former engineer. Cf. Joseph H. Sommer, *Commentary: Where is the Economic Analysis of Payment Law?*, 83 CHI.-KENT L. REV. 751 (2008) (arguing that engineering principles apply to analyzing the law of payment systems); John Kambhu et. al., *Systemic Risk in Ecology and Engineering*, 13 FRBNY ECONOMIC POLICY REVIEW, No. 2, Nov. 2007, at 25 (observing that “several fields of engineering and science share with economics a keen concern with systemic risk”).

¹⁴³ Hsieh, *Chaos and Nonlinear Dynamics*, *supra* note 20. Financial markets originally were modeled as linear systems. The efficient capital market hypothesis (EMH), for example, posits that “the market prices securities as if there was a rational process, whether or not the market’s constituent actors qualify as rational.” Donald C. Langevoort, *Theories, Assumptions, and Securities Regulation: Market Efficiency Revisited*, 140 U. PA. L. REV. 851, 852 (1992). Another model, the random walk theory, is effectively a subset of the EMH because it “maintains that the market is efficient, with prices moving so rapidly in response to new information that investors cannot consistently buy or sell fast enough to benefit.” Thomas Lee Hazen, *The Short-Term/Long-Term Dichotomy and Investment Theory: Implications for Securities Market Regulation and for Corporate Law*, 70 N.C. L. REV. 137, 157 (1991). It is questionable, however, whether the EMH validly describes markets for complex securities, since many legitimate transactions in which securities are issued are “so complex that less than a critical mass of investors can understand them in a reasonable time period [and to that extent] the market will not reach a fully informed price equilibrium, and hence will not be efficient.” Schwarcz, *Rethinking the Disclosure Paradigm*, *supra* note 51, at 19. Moreover, the EMH does not appear to validly describe markets for debt securities. Even publicly-traded debt markets are not efficient. See, e.g., Yedidia Z. Stern, *A General Model for Corporate Acquisition Law*, 26 J. CORP. L. 675, 709 (2001) (“studies show that the bond market is not efficient; and therefore, one cannot expect the market prices to compensate bondholders for the risks to which they are exposed”). Privately-traded debt markets may be even less efficient. *Camden Asset Mgmt., L.P. v. Sunbeam Corp.*, No. 99-8275-CIV, slip op. at 31-36 (S.D. Fla. July 3, 2001) (privately placed Rule 144A-exempt securities, being thinly traded, do not have an efficient market). It therefore is highly unlikely that the EMH validly describes markets for complex *debt* securities—the category that includes virtually all investment securities issued in securitization and other structured financing transactions (STRUCTURED FINANCE, *supra* note 50, § 1:1 at 1-5) and all of the securities involved in the subprime crisis (Schwarcz, *Protecting Financial Markets*, *supra* note 3, at ___).

¹⁴⁴ Cf. Patrick J. Glen, *The Efficient Capital Market Hypothesis, Chaos Theory, and the Insider Filing Requirements of the Securities Exchange Act of 1934: The Predictive Power of Form 4 Filings*, 11 FORDHAM J. CORP. & FIN. L. 85 (2005) (discussing, in the context of the insider filings requirements of the securities laws, the extent to which

Of course, important differences exist between engineered systems and financial markets. Engineers and scientists often can perform real experiments, yielding results that may well be more precise than the results of empirical studies of financial markets. In part this is because interactive market behavior, in which “banks, consumers, firms, . . . investors [and other economic agents] continually adjust their market moves, buying decisions, prices, and forecasts to the situation these moves or decisions or prices or forecasts together create,” adds a “layer of complication . . . not experienced in the natural sciences” where reactions are simpler and more predictable.¹⁴⁵ Engineers also often enjoy the luxury of being able to stop and restart a system.¹⁴⁶ Nonetheless, with appropriate discretion, certain engineering insights translate robustly to financial-market analysis.

Recognizing that “apparently there are no general laws for complexity [and so] one must reach for ‘lessons’ that might, with insight and understanding, be learned in one system and applied to another,”¹⁴⁷ the analysis below explores potential ways that market participants and regulators can attempt to retain the financial-market efficiency, sophistication, and depth afforded by complexity while reducing the potential for its market failures.¹⁴⁸ Because these failures can cut across the specific factual patterns

chaos theory might inform financial market models) Lawrence A. Cunningham, *From Random Walks to Chaotic Crashes: The Linear Genealogy of the Efficient Capital Market Hypothesis*, 62 GEO. WASH. L. REV. 546, 593 (1994) (arguing that markets are nonlinear systems because “deeper structural phenomena” than information about asset values affect market movements). The disconnect between market prices and fundamental underlying asset values in the subprime crisis (*see infra* note 194) provided recent concrete evidence that financial markets have characteristics of nonlinear systems. Cf. Glen, *supra* at 99 (observing that such a disconnect would signal nonlinearity).

¹⁴⁵ Arthur, *supra* note 19, at 107.

¹⁴⁶ J. M. Ottino, *Engineering Complex Systems*, 427 NATURE, Issue no. 6873, Jan. 29, 2004, at 399.

¹⁴⁷ Nigel Goldenfeld & Leo P. Kadanoff, *Simple Lessons from Complexity*, SCIENCE, April 2, 1999, at __ (predicting an increasing study of complexity “with a view to better understanding” economic as well as physical and biological systems).

¹⁴⁸ One reviewer of this article questions, as devil’s advocate, whether the subprime crisis has upset the very conception that, absent market failures, unrestrained financial markets are efficient. Because I have argued that several types of market failures—including

identified in Part II, the analysis is organized functionally by the nature of each failure, first addressing failures arising from uncertainty, then failures arising from nonlinear feedback and tight coupling, and finally failures resulting from conflicts and other forms of “misalignment” that result from complexity.¹⁴⁹

A. Addressing Information Failures Arising from Uncertainty

Uncertainty can cause a variety of financial-market failures, most obviously impairing securities disclosure.¹⁵⁰ This impairment reflects the engineering principle that where a system or structure is complex, the abstractions and simplifications needed to make its problems approachable can introduce significant uncertainty.¹⁵¹ There are at least three possible ways to deal with this impaired disclosure: to tolerate it by relying on efficient-markets theory; to impose regulation proscribing transactions with impaired disclosure; to implement supplemental protections to minimize the impairment.¹⁵² I have

complexity—in fact contributed to the subprime crisis (*see supra* notes 4-5 and accompanying text), I see no justification for that extreme position.

¹⁴⁹ This article does not purport to cover all types of conflicts that could cause market failure, just those that result from complexity. For a more complete discussion of conflicts that could cause market failure, *see Protecting Financial Markets, supra* note 3, at ___, and Steven L. Schwarcz, *Conflicts and Financial Collapse: The Problem of Secondary-Management Agency Costs*, 26 YALE J. ON REG., Issue no. 2 (forthcoming Summer 2009) (symposium issue on the future of financial regulation), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1322536.

¹⁵⁰ *See supra* notes 51-60 and accompanying text (discussing, among other things, that complexity increases the cost of analyzing and valuing securities, and that at some point the cost increase can exceed the benefit gained).

¹⁵¹ MORGAN & HENRION, *supra* note 61, at 47. [In text above, consider giving an example. cite] Uncertainty also might indicate randomness, or an inability to quantify probability. *Id.* at 63 (discussing the Heisenberg uncertainty principle in quantum mechanics, which holds that it is possible to know either the location or the momentum of a particle, but observing one property makes it impossible to observe the other). Sometimes systems might appear random, however, because of an incomplete understanding of the underlying processes. *Id.*

¹⁵² In engineering too, designers of systems must choose to tolerate, eliminate, or provide supplement protections against undesirable byproducts. *Cf.* Nicholas A. Robinson, *Legal Systems, Decisionmaking, and the Science of Earth’s Systems: Procedural Missing Links*, 27 ECOLOGY L. Q. 1077, 1108 (2001) (observing that the harmful exhaust produced as a byproduct by automotive internal combustion engines was tolerated because automobiles have become a transportation necessity but catalytic converters, which eliminate almost 90% of unwanted pollutants, were introduced as a supplemental protection);

shown that toleration does not work because impaired disclosure makes securities markets inefficient.¹⁵³ Because complexity is not an end in itself but usually is a by-product of such salutary goals as seeking to transfer risk to parties better positioned to hold the risk and reducing the cost of funding businesses,¹⁵⁴ proscribing transactions with impaired disclosure would inadvertently ban many beneficial transactions.¹⁵⁵ If, as is likely,¹⁵⁶ the benefits lost exceed the harm averted, proscription would not work. Efficiency demands that the costs of regulation do not exceed its benefits.¹⁵⁷

Similarly, regulatory attempts to limit disclosure costs by standardizing transactions—a more limited form of proscription—would likely have unintended negative consequences.¹⁵⁸ Prof. Gale has argued that investor unfamiliarity with new securities creates “an additional source of uncertainty which is not traceable to the

Dinmukhamed Eshanov, *The Role of Multinational Corporations From the Neoinstitutionalist and International Law Perspectives: The Concept of the Three-Level Game*, 16 N.Y.U. ENVTL L.J. 110, 123 (2008) (observing that despite growing evidence that chlorofluorohydrocarbons were creating a hole in the ozone layer, CFCs were not banned until a viable substitute was created).

¹⁵³ *Disclosure's Failure*, *supra* note 55, at __.

¹⁵⁴ *See supra* notes 7-11 and accompanying text. Even in Enron, complexity was not an end in itself but a (perhaps misguided) attempt to minimize financial-statement losses and volatility, accelerate profits, and avoid adding debt to its balance sheet which could have hurt Enron's credit rating and thereby damaged its credibility in the energy trading business. Schwarcz, *Enron and the Use and Abuse of Special Purpose Entities in Corporate Structures*, *supra* note 11, at 1309-10.

¹⁵⁵ *Disclosure's Failure*, *supra* note 55, at __.

¹⁵⁶ *Id.* at __. Although I find it likely that proscribing transactions with impaired disclosure would inadvertently ban many beneficial transactions, actual empirical cost-benefit balancing is often impossible for anything but a trivial problem. Guido Calabresi, *Transaction Costs, Resource Allocation, and Liability Rules—A Comment*, 11 J. L. & ECON. 67, 70 (1968). Ultimately, regulators must make best guesses regarding the efficacy of proposed actions. *Id.*

¹⁵⁷ *See* RICHARD A. POSNER, *ECONOMIC ANALYSIS OF LAW* § 1.2, at 13-14 (4th ed. 1992) (discussing this “Kaldor-Hicks” standard as the operating standard of efficiency). *Accord*, Louis Kaplow & Steven Shavell, *Fairness Versus Welfare*, 114 HARV. L. REV. 961, 1015 (2001). Cost-benefit balancing is also a well-recognized test for regulatory political viability. For example, before any major rule may take effect in the United States, regulatory agencies must submit a cost-benefit analysis to Congress. Congressional Review of Agency Rulemaking Act, Chap 8, USCA && 801-08.

randomness of the underlying asset returns.”¹⁵⁹ Consistent with Gale, this article has described how the complexities of securities involved in the subprime crisis created significant uncertainty.¹⁶⁰ Regulation, though, is probably not the best way to address this uncertainty. Because market conditions change in real time and thus are more fluid than regulatory change, imposing standardization through law would block design innovations needed to adapt securities to changing markets. Standardization appears to be better achieved by market participants themselves, as would occur when investors charge uncertainty premiums.¹⁶¹

Implementing cost-effective supplemental protections therefore appears to be the best approach to the problem of impaired disclosure. These protections could include guaranties by sellers, such as warranties; governmental and private-sector certifications of quality; and reduction of conflicts of interest.¹⁶²

¹⁵⁸ Cf. *supra* notes 117-119 and accompanying text (discussing unintended negative consequences of accounting regulation).

¹⁵⁹ Douglas Gale, *Standard Securities*, 59 REV. ECON. STUDS. 731, 734 (1992).

¹⁶⁰ See Part II.B, *supra*. In this context, it is somewhat ironic that securitization itself is a means of standardizing the underlying assets, securitized assets being “more likely to be considered as part of a standardized class of assets than any one specific mortgage would be.” Hellwig, *supra* note 4, at 13. Prof. Hellwig has “serious doubts,” however, about the second and higher tiers of securitization represented by CDO and ABS CDO securities. Even though these additional layers “will provide for additional risk diversification,” their “benefits seem ephemeral [because investors could diversify with multiple MBS investments] and the potential incentive effects large [e.g., increasing the scope for moral hazard by further diluting incentives for institutions handling the MBS stage to actively control the quality of the mortgages they were packaging].” *Id.* at 23-24.

¹⁶¹ Cf. Gale, *supra* note 159, at 731 (arguing that investors will charge an “uncertainty premium” on unfamiliar securities). I do not know whether investors charged sufficient uncertainty premiums in the subprime crisis. Any failure to do so may well be due to the other market failures described in this article, such as conflicts of interest. See *infra* notes 284-291 and accompanying text. [Consider the extent to which standardization would help to solve the problem that investors in the originate-to-distribute model may have insufficient incentive to understand each unique investment. Compare similar incentive of much less sophisticated *borrowers* looking at more standardized mortgage products. Cite-SLS]

¹⁶² Schwarcz, *Disclosure’s Failure*, *supra* note 55, at ___.

In a limited sense, a form of seller “guaranty” is being considered for financial markets by having underwriters of securities disclose that they hold (and intend to continue to hold) exposure to pari passu or subordinate positions in the securities being sold. In this way, the underwriter puts “skin in the game” to signal its belief in the safety of the securities.¹⁶³

This approach, however, can sometimes backfire.¹⁶⁴ In the subprime crisis, for example, underwriters customarily purchased some portion of the subordinated “equity” tranches of ABS CDO securities to demonstrate their belief in the securities being sold.¹⁶⁵ Unfortunately, many of these underwriters did not fully understand the risks associated with their retained tranches, resulting in what can be called a “mutual misinformation” problem: by signaling its (unjustified) confidence in the securities being sold, the seller inadvertently misleads investors into buying those securities.¹⁶⁶ Mutual-misinformation problems are intractable almost by definition. Nonetheless, to the extent these problems are caused by the inherent uncertainty of securities being priced off quantitative models in the absence of an actual or active market,¹⁶⁷ the depth of the resulting losses in the

¹⁶³ Fitch Ratings Special Report, *Exposure Draft: Retaining Equity Piece Risk—Enhancing Transparency 2* (June 24, 2008) (seeking market feedback as to whether to invite key transaction parties to disclose whether they retain economic risk in the securities being sold). *See also* European Securities Market Expert Group, *Role of Credit Rating Agencies* (June 2008) (recommending that rating agencies disclose information regarding an originator’s or sponsor’s retained interest in securities). These approaches are not, of course, true guaranties because investors would have no claim for losses. For a suggestion, albeit unrealistic, that true guaranties be used, *see* Daniel Andrews, *The Clean Up: Investors Need Better Advice on Structured Finance Products*, 26 INT’L FIN. L. REV. 14, 14 (Sept. 2007).

¹⁶⁴ Fitch also notes, *supra* note 163 at 1, that there are “currently no data available to assess whether such retention or non-retention of equity piece risk actually has a greater impact on a transaction’s performance”).

¹⁶⁵ *Protecting Financial Markets*, *supra* note 3, at ___. *Cf.* Hellwig, *supra* note 4, at 16 (observing that “as time went on, ever greater portions of equity tranches were sold to outside investors”).

¹⁶⁶ This approach also could be misleading to the extent, for example, the retained securities bear higher interest rates than those being sold, compensating for the risk. Failure to disclose that higher rate, however, is likely to constitute securities law fraud, at least in the United States.

¹⁶⁷ *See supra* notes 86-88 and accompanying text.

subprime crisis suggests that investors, at least in the short term, are likely to avoid such reliance, obviating the need for a regulatory response.¹⁶⁸ Still, because investors over time tend to choose higher rates of return over investment discipline,¹⁶⁹ there may come a time when regulation, or its threat, is needed to restore that discipline.

Private-sector certifications of quality can also improve impaired securities disclosure, especially where the certification achieves an economy of scale. This approach is currently employed, for example, through rating-agency ratings on debt securities.¹⁷⁰ In the subprime crisis, however, rating agencies were said to contribute to the crisis,¹⁷¹ and there are various proposals under consideration to improve the quality of the rating system.¹⁷² Although it is too early to know the extent to which these proposals will improve the rating system, it is doubtful that any type of government certification would be more successful. In the United States, at least, private-sector analysts tend to be more capable and more accountable than government analysts due at least in part to the former's higher compensation incentives.¹⁷³

These are all only second-best or partial solutions to the problem of uncertainty. There do not, however, appear to be any perfect solutions. Government already takes a somewhat paternalistic stance by mandating minimum investor sophistication for investing in complex securities, yet sophisticated investors and qualified institutional buyers (QIBs) are the very investors who lost the most money in the subprime financial

¹⁶⁸ Cf. *infra* notes 281-282 and accompanying text (observing that investors tend, over time, to forsake investment discipline for higher rates of return).

¹⁶⁹ See *infra* note 282.

¹⁷⁰ See *supra* note 77 and accompanying text (observing, among other things, that debt securities are rated by their likelihood of timely payment).

¹⁷¹ *Protecting Financial Markets*, *supra* note 3, at ___.

¹⁷² *Id.* at ___. Cf. Richard Barley, *Ability to Track Risk Has Shrunk 'Forever'-Moody's*, REUTERS, Jan. 6, 2008 (explaining a statement by Moody's Investor Services that in the face of extreme complexity arising from financial innovation, the ability to track risk had been severely undermined, and that market participants should be required to hold additional capital).

¹⁷³ *Id.* at ___.

crisis.¹⁷⁴ And any attempt by government to restrict firms from engaging in complex transactions would be risky because of the potential of inadvertently banning beneficial transactions.¹⁷⁵

The discussion above addresses when uncertainty causes failure through impaired securities disclosure. Uncertainty also can cause failure when information about market participants is not made public. This is illustrated by counterparty risk among market participants on CDS and other derivatives contracts.¹⁷⁶ This risk is problematic because market participants are unable to discern how much contingent exposure their counterparties have to other market participants.¹⁷⁷

Counterparties can mitigate this risk voluntarily by disclosing their contingent liabilities on credit derivatives. Regulation also can enhance the disclosure, such as by requiring counterparties to credit derivatives transactions, or intermediaries for those parties, to keep a registry of the transactions from which market participants can ascertain risk allocation.¹⁷⁸ The extent to which enhanced disclosure will prove useful is uncertain, though. Under generally accepted accounting principles (“GAAP”), counterparties are

¹⁷⁴ See, e.g., Jenny Anderson, *Wall St. Banks Confront a String of Write-Downs*, N.Y. TIMES, Feb. 19, 2008, at C1 (reporting that “major banks . . . have already written off more than \$120 billion of losses stemming from bad mortgage-related investments”); Randall Smith, *Merrill’s \$5 Billion Bath Bares Deeper Divide—After Big Write-Down Tied to Mortgage Debt, O’Neal Asserts Control*, WALL ST. J., Oct. 6, 2007, at A1 (reporting a total of \$20 billion in write-downs by large investment banks).

¹⁷⁵ See *supra* notes 154-156 and accompanying text. See also Gerard Caprio, Jr., Ash Demirguc-Kunt, & Edward J. Kane, “The 2007 Meltdown in Structured Securitization: Searching for Lessons Not Scapegoats” 5 (Nov. 23, 2008 draft), available at www.ssrn/abstract_id=1293169 (observing that “a tightly regulated financial system hampers growth”).

¹⁷⁶ See *supra* notes 132-140 and accompanying text.

¹⁷⁷ See *supra* notes 136-138 and accompanying text.

¹⁷⁸ See, e.g., Christopher Cox, Op-Ed, *Swapping Secrecy for Transparency*, N.Y. TIMES, Oct. 19, 2008, at A__ (arguing that “Congress could require that dealers in over-the-counter credit-default swaps publicly report both their trades and the value of those trades”).

already required to disclose many of their contingent liabilities.¹⁷⁹ However, subtle judgment calls must be made as to how likely a contingency is to occur. If a counterparty assesses the likelihood as higher than it actually is, market participants may unnecessarily avoid doing business with the counterparty. But if the counterparty assesses the likelihood as lower than it actually is, market participants may be under-pricing the risk of doing business with the counterparty.¹⁸⁰

Another hurdle to imposing enhanced disclosure through regulation is that derivatives are chameleon-like—they easily can change form and appearance—and there are myriad ways that risk can be transferred in transactions not regarded as derivatives, such as a simple guarantee for payment of a fee. Even a simple loan agreement can be characterized as a credit derivative.¹⁸¹ Any regulation of credit derivatives therefore will have to grapple with the problem of defining what is being regulated, with a narrow focus

¹⁷⁹ Contingent liabilities must be disclosed, at least in the footnotes to a firm's financial statements, if the contingency is merely a "reasonable possibility." ACCOUNTING FOR CONTINGENCIES, Statement of Financial Accounting Standards No. 5, at 6 (Fin. Accounting Standards Bd. 1975) (allowing only remote risks to remain undisclosed). Sarbanes–Oxley also attempts to maximize GAAP disclosure of contingent liabilities by amending § 13 of the Securities Exchange Act of 1934 (15 U.S.C. § 78m (2005)) to add a new subsection (j), requiring the SEC to issue "[f]inal rules providing that each annual and quarterly financial report required to be filed with the Commission shall disclose all material off-balance sheet transactions, arrangements, obligations (including contingent obligations), and other relationships of the issuer with unconsolidated entities or other persons, that may have a material current or future effect on financial condition, changes in financial condition, results of operations, liquidity, capital expenditures, capital resources, or significant components of revenues or expenses." Sarbanes–Oxley Act § 401(j). [update this footnote-cite]

¹⁸⁰ Another possible approach to mitigate counterparty risk might be for CDS contracts, which have many characteristics of insurance (STRUCTURED FINANCE, *supra* note 50, §10:4.1), to be regulated like insurance policies. This approach is beyond this article's scope.

¹⁸¹ *Cf.* 11 U.S.C. § 101(53B) (broadly defining a "swap agreement"). *Cf.* ANDREW M. CHISHOLM, DERIVATIVES DEMYSTIFIED: A STEP-BY-STEP GUIDE TO FORWARDS, FUTURES, SWAPS AND OPTIONS 1 (2004) (defining a derivative an asset whose value is derived from the value of some other asset known as the underlying); 12 C.F.R. 563.172 (defining a financial derivative as a financial contract whose value depends on the value of one or more underlying assets, indices, or reference rates).

potentially omitting risk transfers that should be covered and a broad focus potentially being overly restrictive by including traditional commercial transactions.

If disclosure-related approaches are inadequate to address the uncertainty and information failures caused by credit derivatives, the next step might be to consider banning or otherwise limiting credit derivatives. This article does not get to that next step.¹⁸² Risk transfer is not inherently bad, and indeed that it can maximize efficiency if risk is transferred—as is the goal of credit derivatives—to parties better able to bear the risk.¹⁸³ Nonetheless, future research should explore whether, as might have occurred in the subprime crisis, credit derivatives have dispersed risk so broadly as to create a type of collective-action problem: the ultimate risk-bearing parties do not always have sufficient amounts at risk regarding any given underlying credit risk to motivate them to engage in due diligence.¹⁸⁴

Lastly, it should be recalled that the indirect-holding system for securities increases uncertainty about market participants.¹⁸⁵ The proper response in this context is complicated by the fact that the indirect-holding system evolved to reduce the costs of record-keeping and to lower the risk of loss occasioned by physically transferring securities.¹⁸⁶ Any approach to deviate from that system in order to reduce uncertainty would thus have to take into account the possibility of increasing record-keeping costs and losses—an analysis beyond the scope of this article. In another context, however, this article proposes that a firm should be able, at least during crises of investor confidence

¹⁸² *But cf. supra* notes 154-161 and accompanying text (arguing that proscribing transactions with impaired disclosure would inadvertently ban many beneficial transactions).

¹⁸³ REPORT OF THE PRESIDENT'S WORKING GROUP ON FINANCIAL MARKETS, HEDGE FUNDS, LEVERAGE, AND THE LESSONS OF LONG TERM CAPITAL MANAGEMENT __ (1999).

¹⁸⁴ *Protecting Financial Markets, supra* note 3, at __. Any regulation limiting credit derivatives would similarly have to grapple with the problem of defining what is being regulated. *See supra* note 181 and accompanying text.

¹⁸⁵ *See supra* note 112 and accompanying text (observing that third parties cannot readily determine who owns, and thus has credit exposure to, specific securities because there is no single location from which they can easily get that information).

¹⁸⁶ *See supra* note 111 and accompanying text.

and turbulent markets, to avoid having to mark its securities portfolio to market by fully disclosing its underlying asset portfolio.¹⁸⁷ This same approach could be used to reduce uncertainty without needing to modify the indirect-holding system.

B. Addressing Failures Arising from Nonlinear Feedback and Tight Coupling

Recall that when financial markets exhibit properties of a complex system, the ability to predict consequences, such as cause-and-effect explanations for market movements, is frustrated by nonlinear feedback effects arising from interactivities.¹⁸⁸ Nonlinear feedback is especially dangerous when combined with tight coupling.¹⁸⁹

Currently, the most significant such combination is marking to market.¹⁹⁰ Although marking to market generally stabilizes financial markets by creating trust that assets are fairly valued, it destabilizes markets when investors lose confidence during times of market turbulence; then, requiring firms to sell assets to meet margin calls can artificially depress asset prices, causing a downward spiral.¹⁹¹

This type of interactive complexity has led some to argue that quantitative tools should be augmented to perceive and account for the “observable and systematic” behavioral patterns that emerge as usually diverse market segments begin moving in lock-step, or where investors exhibit herding behavior.¹⁹² In the case of marking to market, one way to account for the interactive pattern is to recognize, as the subprime crisis has revealed, that liquidity and default are not always correlated.¹⁹³ In that crisis,

¹⁸⁷ See *infra* notes 197-201 and accompanying text.

¹⁸⁸ See *supra* notes 124-130 and accompanying text. It is less useful to try to determine which is the cause and which is the effect than to try to understand the interactive patterns and potential feedback effects.

¹⁸⁹ See text accompanying note 117, *supra*.

¹⁹⁰ See *supra* notes 117-124 and accompanying text.

¹⁹¹ See *id.*

¹⁹² Alan Greenspan, *We Will Never Have a Perfect Model of Risk*, FIN. TIMES, Mar. 17, 2008, at 9.

¹⁹³ See, e.g., Dr. Alexander Dibelius, Chairman, Goldman Sachs Deutschland, Address at the International Berlin Business and Trade Law Conference, Humboldt University (June

holders of securities that were unaffected by defaults found it difficult to sell or refinance those securities.¹⁹⁴ This difficulty in turn created an even greater crisis of confidence, causing the market to collapse.¹⁹⁵ At least part of the problem was caused by the requirement that firms sell the securities as market prices drop, causing prices to drop further.¹⁹⁶

This downward spiral could have been mitigated, if not prevented, by recognizing that when investors lose confidence and markets become turbulent,¹⁹⁷ marking to market can be misleading and potentially dangerous.¹⁹⁸ Although the feedback effect of marking to market dampens price perturbations in normal times, thereby stabilizing the financial system, the feedback effect of marking to market amplifies perturbations when investors lose confidence, thereby de-stabilizing the financial system.¹⁹⁹ Firms then should be allowed to substitute other measures of investor comfort for marking to market. One possible approach, for example,²⁰⁰ is to allow a firm otherwise required to mark to market to have the option, instead, to disseminate full disclosure of its underlying asset portfolio.²⁰¹ For example, a firm that owns CDO securities could choose to disclose

12, 2008) (notes on file with author) (observing that liquidity and default are not necessarily correlated).

¹⁹⁴ See, e.g., *Bank of New York v. Montana Bd. Of Investments*, [2008] E.W.H.C. 1594 (Ch.) (observing, at paragraph 21 of the opinion, that extreme illiquidity in the structured products markets reduced the market value of the (largely non-defaulted) collateral to significantly less than the present value of the collateral's expected cash flows).

¹⁹⁵ Dibelius, *supra* note 193.

¹⁹⁶ See *supra* notes 122-123 and accompanying text.

¹⁹⁷ Cf. Paul Krugman, *A Catastrophe Foretold*, NY TIMES, Oct. 26, 2007, at A25 (asserting that the downgrade of AAA bonds created a "crisis of confidence" in financial markets).

¹⁹⁸ CRMPG III REPORT, *supra* note 57, at 132-33.

¹⁹⁹ Cf. *id.* Cf. also "Is the Securitization Crisis Driven by Nonlinear Systemic Processes?," GUIDE POST (May 12, 2008 blog).

²⁰⁰ Another possible approach, suggested by Professor Ron Blasi, is to base mark-to-market accounting on a trailing average rather than a one-day snapshot of market values. Memorandum from Ronald W. Blasi, Professor of Law, Georgia State University, to the author (Nov. 17, 2008) (on file with author). This approach would at least dampen the amplifying perturbations.

²⁰¹ This "full disclosure" option has been proposed by Dr. Alexander Dibelius, *supra* note 193, and also by Donald S. Bernstein, Partner & head, Insolvency & Restructuring

details about the mortgage loans and other financial assets underlying those securities in lieu of marking the securities to market,²⁰² thereby enabling investors and other market participants to make more transparent valuations. This approach also would help reduce the anomaly,²⁰³ seen during the subprime crisis, of securities bearing market values significantly lower than the present value of their reasonably expected cash flows.²⁰⁴

As financial markets evolve, other nonlinear feedback effects will undoubtedly become tightly coupled in ways one cannot predict *ex ante*. Consideration therefore should be given to more broad spectrum solutions.²⁰⁵ One such possible approach is to establish an entity to act, if needed, as a market liquidity provider of last resort (hereinafter, “market liquidity provider”) in order to more loosely couple the feedback effects.²⁰⁶ This approach takes inspiration from engineering design, in which de-coupling systems through modularity helps to reduce the chance that a failure in one part of a

Practice Group, Davis Polk & Wardwell, in remarks at the International Insolvency Institute’s Eighth Annual International Insolvency Conference (June 10, 2008; notes on file with author).

²⁰² See *supra* note 46 and accompanying text (describing the assets that underlay CDO securities).

²⁰³ For an interesting conjecture on whether this indeed is anomalous, see Hellwig, *supra* note 4, at 41 (arguing that although the notion that the market value of securities may be significantly below the expected present value of their future cash flows “seems incompatible with the theory of asset pricing in informationally efficient markets,” it can be explained by limitations on investor funds or investor worries about refinancing).

²⁰⁴ See *Understanding the ‘Subprime’ Mortgage Crisis*, *supra* note 4; International Monetary Fund, *Containing Systemic Risks and Restoring Financial Soundness*, GLOBAL FIN. STABILITY REP. (Apr. 2008) (suggesting that the market prices of at least some mortgage-backed securities may be significantly below the expected present values of their future cash flows). This amount could be roughly estimated by examining the mortgage loans underlying the securities and ascertaining which were subprime, which were prime, and which were delinquent or in default. See Simon Gervais & Steven L. Schwarcz, “Valuation of Risky Cash Flows” (working paper on file with author).

²⁰⁵ Cf. CRMPG III REPORT, *supra* note 57, at 102 (proposing that a resilient market for credit derivatives requires that shocks be “absorb[ed], rather than amplify[ied]”).

²⁰⁶ See *infra* notes 212-229 and accompanying text (discussing how a liquidity provider of last resort could more loosely couple financial-market feedback effects). For a discussion of logistical and cost-benefit issues associated with a liquidity provider of last resort, see *infra* notes 229-XX and accompanying text.

complex system will trigger a failure in another part.²⁰⁷ “Modularity allows complexity to become manageable by . . . partially closing off some parts of the system and allowing these encapsulated components to interconnect only in certain ways.”²⁰⁸ Thus, when a component of a system fails, modularity enables repairs to be made before the entire system shuts down.²⁰⁹

Using modularity to reduce danger from complex systems is also consistent with chaos theory,²¹⁰ which posits that small collapses can enhance the stability of complex systems “the way an area of tectonic activity might produce thousands of small tremors in order to avoid a severe earthquake.”²¹¹ Chaos theory recognizes that, in complex systems, failures are almost inevitable, and that successful systems are those in which the consequences of a failure are limited.²¹²

A market liquidity provider would work in much this same way, providing functional “modularity” to limit the consequences of financial-market failure by directly investing in securities of panicked markets. Financial markets rely critically on the supply of liquidity in the form of credit.²¹³ If a failure deprives a particular market of liquidity, a

²⁰⁷ Charles B. Perrow, *Complexity, Catastrophe, and Modularity*, 78 *SOCIOLOGICAL INQUIRY*, Issue no. 2, at 162-73 (2008).

²⁰⁸ Henry E. Smith, *Panel Four: Boilerplate Versus Contract: Modularity in Contracts: Boilerplate and Information Flow*, 104 *MICH. L. R.* 1175, 1180 (2006).

²⁰⁹ *Id.* See also Zuoyi Zhang & Yuliang Sun, *Economic Potential of Modular Reactor Nuclear Power Plants Based on the Chinese HTR-PM Project*, *NUCLEAR ENGINEERING & DESIGN* 2265 (2007) (explaining that, after the Three-Mile Island reactor meltdown, nuclear power plants began to use modularity to increase safety measures against similar, nonlinear catastrophes).

²¹⁰ See *supra* note 144 and accompanying text (introducing chaos theory).

²¹¹ J.B. Ruhl, *The Arrow of the Law in Modern Administrative States: Using Complexity Theory to Reveal the Diminishing Returns and Increasing Risks the Burgeoning of Law Poses to Society*, 30 *U.C. DAVIS L. REV.* 405, 467-68 (1997). See also PER BAK, *HOW NATURE WORKS: THE SCIENCE OF SELF-ORGANIZED CRITICALITY* (1996) (first positing how small collapses can enhance complex system stability).

²¹² Ruhl, *The Arrow of the Law in Modern Administrative States*, *supra* note 211; BAK, *HOW NATURE WORKS*, *supra* note 211, at __.

²¹³ See *supra* note 108 and accompanying text.

market liquidity provider can restore liquidity before that market collapses and endangers other financial markets.²¹⁴

For example, a market liquidity provider could provide market liquidity²¹⁵ by investing in securities of artificially falling financial markets—markets in which the price of securities falls below the intrinsic value of the assets underlying the securities (which might result from a panic, as occurred in the subprime crisis when mortgage-backed securities prices fell below the present value of the expected cash flows on the underlying mortgages²¹⁶)²¹⁷—thereby stabilizing asset prices and dampening the over-amplification of marking to market that can lead to market collapse.²¹⁸

²¹⁴ Cf. Michael D. Bordo, Bruce Misrach, & Anna Schwartz, NBER Working Paper Series (No. 5371), *Real Versus Pseudo-International Systemic Risk: Some Lessons From History* 19 (1995) (observing that financial panic will not usually become contagious when a lender of last resort provides adequate liquidity). In the Great Depression, for example, economists believe that the negative effects would have been considerably muted through actions by the government central bank to provide the needed liquidity to maintain stability within the monetary supply. *Id.* at 21.

²¹⁵ For clarity, this discussion differentiates “market illiquidity,” in which illiquidity in a market causes specific assets in that market to be undervalued, from “funding illiquidity,” in which illiquidity in a market for short-term investments threatens to undermine long-term investments that are funded by the short-term investments. Cf. *infra* notes 219-221 and accompanying text (discussing funding liquidity). Both market illiquidity and funding illiquidity are forms of illiquidity in markets. The author thanks Laura Ellen Kodres, Chief, Global Financial Stability Division, International Monetary Fund, for pointing out this distinction.

²¹⁶ See *supra* note 204 and accompanying text.

²¹⁷ The mechanics of timing purchases will be critical. Because markets normally can fluctuate widely, a market liquidity provider should contemplate acting only when fluctuations are outside of normal ranges.

²¹⁸ See *supra* notes 117-123 & 197-199 and accompanying text (discussing how marking to market in turbulent financial markets can lead to market collapse). In the subprime crisis, for example, a market liquidity provider could have stepped in to purchase sufficient quantities of market-backed securities to stabilize the MBS markets. Say the intrinsic value was 80-90 cents on the dollar and the market price had fallen to 22 cents on the dollar (numbers representing the author’s experience); the market liquidity provider could purchase these securities at, say, 70 cents on the dollar, thereby stabilizing the market and still making a profit. For an explanation of why, if prices are artificially low, private investors cannot be counted on to invest and make this profit, see *infra* notes 243-246 and accompanying text.

A market liquidity provider also could address temporary problems of funding illiquidity. This occurs when illiquidity in a market for short-term investments threatens to undermine long-term investments that are funded by the short-term investments. For example, an investment vehicle, such as an asset-backed commercial paper (“ABCP”) securitization conduit,²¹⁹ may fund the purchase of long-term financial assets, such as bonds, by issuing short-term commercial paper, expecting to refinance by issuing new commercial paper (i.e., “rolling over” the commercial paper). If the market for commercial paper is temporarily disrupted, as occurred during the subprime crisis, and the securitization conduit cannot obtain immediate alternative financing, it will default.²²⁰ In instances where market participants reasonably use short-term funding to invest in long-term assets and the market illiquidity is unexpected and temporary,²²¹ a market liquidity provider could consider providing the alternative financing.²²²

In these ways, a market liquidity provider not only would reduce the chance of any given financial market collapse by restoring liquidity but also would reduce systemic risk by de-coupling the chance that a failure in one market would trigger a failure in other markets.²²³

²¹⁹ For a brief primer on ABCP securitization conduits, see Michael Durrer, *Asset Backed Commercial Paper Conduits*, 1 N.C. BANKING INST. 119, 119 (1997).

²²⁰ Policy Statement on Financial Market Developments: The President’s Working Group on Financial Markets, 14 LAW & BUS. REV. AM. 447, 455-56 (2008) (suggesting that some 30% contraction of the ABCP market in the U.S. in 2007 was a factor contributing to the financial crisis).

²²¹ The conditions that the use of short-term funding to invest in long-term assets be reasonable and that any market illiquidity be unexpected are intended to minimize moral hazard. See *infra* note 235 and accompanying text.

²²² Cf. Hellwig, *supra* note 4, at 39 (observing that “[s]hort of buying the securities themselves, the central-bank intervention [in the subprime crisis] could not eliminate the systemic problem that, with the breakdown of conduit and SIV refinancing, there was a large overhang of long-term asset-backed securities that needed refinancing at a time when the fundamental value of these assets was questionable and the associated risks were seen as a potential threat to any institution that was holding them”). The ability to invest directly in market securities can also protect the integrity of secondary markets for re-sale of securities. Schwarcz, *Systemic Risk*, *supra* note 4, at 225-28.

These roles of a market liquidity provider go substantially beyond the U.S. Federal Reserve's historical actions as lender of last resort to financial institutions, much less the actions of other national central banks. Under the Federal Reserve Act, the Federal Reserve is authorized to, and customarily does, offer loans to banks that need credit.²²⁴ In response to the subprime crisis, the Federal Reserve extended its lending availability to “near banks” like investment banks.²²⁵ If needed, the Fed even has power to extend lending availability to any entity, not merely banks and near banks, whose failure might bring down the larger financial system.²²⁶ The extent of the Fed's power, much less its willingness, to provide liquidity to markets directly is less clear, however.²²⁷

²²³ Cf. *supra* notes 207-214 and accompanying text (referring to this as functional modularity).

²²⁴ [cite] Section 13(3) of the Federal Reserve Act (12 U.S.C. § 343) enables the Board of Governors of the Federal Reserve System, in “unusual and exigent circumstances,” to “authorize any Federal reserve bank . . . to discount for any individual, partnership, or corporation, notes, drafts, and bills of exchange” if such individual, partnership, or corporation is “unable to secure adequate credit accommodations from other banking institutions.” The publicity about the original “liquidity injections” by the Federal Reserve in response to the subprime crisis did not represent direct increases in money availability but merely a lowering of the “discount rate” at which such loans are made, thereby providing a more attractive borrowing environment for banks. *See, e.g.*, Jeremy W. Peters, *The Basics: The Banks Roll Up Their Sleeves*, N.Y. TIMES, Aug. 19, 2007, Wk. in Rev., at 2 (observing that when the Federal Reserve makes “liquidity injections” into the banking system, “the Fed doesn’t even use real money,” and explaining that liquidity results from offering Fed loans to banks at the discount rate, a lower interest rate than the “fed funds rate” that banks would charge other banks on interbank loans). Moreover, that “liquidity injection” affected only banks, not non-banks or financial markets. [cite]

²²⁵ Federal Reserve Chairman Ben Bernanke, testimony before the House Financial Services Committee, *Transcript of the Hearing of the House Financial Services Committee, Systemic Risk and the Financial Markets*, Federal News Service, July 10, 2008.

²²⁶ *See supra* note 224 (referencing Section 13(3) of the Federal Reserve Act, which enables the Board of Governors of the Federal Reserve System, in “unusual and exigent circumstances,” to “authorize any Federal reserve bank . . . to discount for any individual, partnership, or corporation, notes, drafts, and bills of exchange”) (emphasis added). 12 U.S.C. § 343 (2008).

²²⁷ [Update to Emergency Economic Stabilization Act of 2008 and to Obama’s revised financial bailout plan, discussed *infra* note 248. cite]

Adaptation in that direction is critical, though, because of the ongoing shift, known as disintermediation, of the source of corporate financing from banks to financial and capital markets.²²⁸ This article’s conception of a market liquidity provider would take on this new role of protecting these markets directly. Had such a market liquidity provider been in existence when the subprime crisis started, the resulting collapse of the credit markets may well have been restricted in scope and lessened in impact.²²⁹

The above discussion begs the question of whether these potential benefits of using a market liquidity provider would exceed its costs. As shown below, a market liquidity provider should generate relatively minimal costs, and certainly lower costs than those of a lender of last resort.²³⁰ In related contexts, I have shown the relevant costs to be taxpayer expense and moral hazard.²³¹ By providing a lifeline to financial institutions, a lender of last resort fosters moral hazard by potentially encouraging these institutions—especially those that believe they are “too big to fail”—to be fiscally reckless.²³²

²²⁸ Schwarcz, *Systemic Risk*, *supra* note 4, at 200.

²²⁹ *Id.* at 229, 248-49. *See also supra* notes 216-218 and accompanying text.

²³⁰ Another way to help transform our tightly-coupled financial system into one that is more weakly coupled would be to require near banks (*see supra* note 225 and accompanying text, defining “near banks”) to maintain minimum capital requirements, like banks. Capital requirements, however, are very expensive. *See, e.g.*, Michael E. Bleier, *Operational Risk in Basel II*, 8 N.C. BANKING INST. 101, 103-04 (April 2004) (“The new capital requirement for operational risk can be fairly expensive for specialized financial institutions with significant concentration in asset management, custody, and other businesses that would, for the first time carry a capital requirement.”); Raj Bhala, *Banking Law Symposium: Applying Equilibrium Theory and the Ficas Model: A Case Study of Capital Adequacy and Currency Trading*, 41 ST. LOUIS L.J. 125, 132 (1996) (observing that “the greater the capital requirements, the more expensive it is to trade in the markets”).

²³¹ *See* Schwarcz, *Systemic Risk*, *supra* note 4, at 225-30; Steven L. Schwarcz, *Sovereign Debt Restructuring: A Bankruptcy Reorganization Approach*, 85 CORNELL L. REV. 956, 961-66 (2000).

²³² *See, e.g.*, Gary H. Stern & Ron J. Feldman, *Too Big to Fail: The Hazards of Bank Bailouts* (2004); Robert L. Hetzel, *Too Big to Fail: Origins, Consequences, and Outlook*, FED. RES. BANK OF RICHMOND ECON. REV. 3 (Nov.-Dec. 1991). Although ideally a lender of last resort should adopt a policy of “constructive ambiguity” in its lending decisions and further restrict its lending to entities that are merely experiencing temporary liquidity crises but that otherwise are financially healthy (Schwarcz, *Systemic*

Moreover, loans made to these institutions will not be repaid if the institutions eventually fail.

In contrast, a market liquidity provider, especially if it acts at the outset of a market panic, can profitably invest in securities at a deep discount from the market price and still provide a “floor” to how low the market will drop.²³³ Indeed, this article proposes that a market liquidity provider should consider providing market liquidity *only* when it believes it can profit (or at least break even) because its mission should be to correct market failures, such as might be caused by a panic or other investor overreaction.²³⁴ Moral hazard should also be minimized: speculative investors will be hurt by the market liquidity provider’s deeply discounted purchases, and investing in markets, not institutions directly, should reduce institutional rent-seeking behavior.²³⁵ In economic terms, therefore, any safety-net subsidies created by a market liquidity provider will be much smaller than those created by a lender of last resort.²³⁶

Perhaps for these reasons, the United States Department of the Treasury, responding to the possible collapse of Fannie Mae and Freddie Mac, recently announced that it will purchase securities issued by Fannie and Freddie to the extent investors do not

Risk, *supra* note 4, at 226-27), these restrictions may not be politically viable if the entity’s failure would negatively impact the real economy. [cite]

²³³ See *supra* notes 216-222 and accompanying text (explaining why, in the subprime crisis, a market liquidity provider could have profitably purchased mortgage-backed securities at a deep discount and still have stabilized the market significantly above the present disastrous levels).

²³⁴ See *supra* notes 214-218 and *infra* notes 243-244 and accompanying text.

²³⁵ In contrast, a market liquidity provider used to finance temporary problems of funding illiquidity (see *supra* notes 218-222 and accompanying text) could increase moral hazard to the extent market participants use less care in addressing funding gaps. This article’s proposal—that a market liquidity provider consider providing such financing only when market participants have reasonably used short-term funding to invest in long-term assets and the subsequent market illiquidity is unexpected—is intended to minimize that moral hazard. See *supra* note 221.

²³⁶ Cf. Caprio, Demirguc-Kunt, & Kane, *supra* note 175, at 9 (arguing that the goal of financial regulation and supervision is “to manage the [regulatory] safety net so that private risk-taking is neither taxed nor subsidized”); *id.* at 6 (arguing that, ideally,

do so, thereby stabilizing the mortgage-backed securities markets and reducing mortgage rates.²³⁷ This is the first time that any government entity has agreed to act in a market-liquidity-provider capacity.²³⁸

One might ask whether failed efforts of governments to try to control their currency exchange rates indicate that a market liquidity provider, even if governmental, would have insufficient spending power to stabilize irrationally panicked debt markets. Only Hong Kong was able to control its currency exchange rate, and that was because its reserves, which implicitly included all of China's reserves, were large enough to be credible.²³⁹ There are important distinctions, though, between controlling a currency exchange rate and stabilizing an irrationally panicked debt market. Controlling a currency exchange rate depends on all of the macroeconomic factors to which the country in question is subject whereas stabilizing a panicked debt market depends mostly on factors specific to the debt securities in question. Also, because the market liquidity provider should consider acting only when a panicked debt market is so irrational that the market value of its securities is significantly below their intrinsic value,²⁴⁰ the market liquidity provider should be able to stem the information asymmetry leading to this valuation differential by explaining the irrationality and, by buying at an above-market price,

regulated parties should not have opportunities to “shift the deep downside of their risk exposures onto the [regulatory] safety net”).

²³⁷ Statement by Henry M. Paulson, Secretary of the Treasury, United States Department of the Treasury, “Treasury and Federal Housing Finance Agency Action to Protect Financial Markets and Taxpayers” (Sep. 7, 2008). Although this was one of four steps announced by Secretary Paulson to address the problems of Fannie Mae and Freddie Mac, the other steps—placing these entities into conservatorship, committing to purchase senior-priority preferred stock in these entities to maintain a positive net worth, and establishing a secured lending credit facility for these entities—would have no application to stabilizing financial markets generally.

²³⁸ [Update to include more recent governmental efforts to provide liquidity to the commercial paper market. cite]

²³⁹ [cite]

²⁴⁰ See *supra* notes XX-XX and accompanying text. The market liquidity provider also could act to prevent funding illiquidity, but the amounts needed for that purpose should be relatively small.

putting its money where its mouth is.²⁴¹ It effectively would be providing to investors in that debt market the same type of real credibility and comfort that a country's large reserves provide to currency investors.²⁴²

One also might ask why, if a market liquidity provider can invest in securities at a deep discount to stabilize markets and still make money, private investors will not also do so. The answer, at least in part, is that individuals at investing firms may not want to jeopardize their reputations (and jobs) by causing their firms to invest at a time when other investors have abandoned the market.²⁴³ Empirical evidence confirms that individuals engage in this type of "herd behavior."²⁴⁴ Private investors are also risk

²⁴¹ The ability of a market liquidity provider to stabilize market prices might have particular problems in a thin market that does not react responsively to its purchases. In the subprime crisis, for example, at least a portion of the MBS markets, including those for ABS CDO securities, were privately-placed debt markets. Nonetheless, there was a virtual market for ABS CDO securities, created by the ABX.HE indices. This virtual market was sufficiently large that it should have reacted responsively to purchases made by a market liquidity provider. [cite] (The ABX.HE indices simulate the risk and reward of trading in asset- and mortgage-backed securities. A potential investor, for example, can decide to invest in asset-backed securities represented by one of the indices, without actually purchasing the underlying securities. The investor is thus not limited to specific securities, or to amounts of those securities that are actually physically available for purchase. The ABX.HE indices also help to facilitate hedging. A lender, dealer, or hedge fund with excessive asset-backed securities exposure, for example, not only can attempt to buy protection from counterparties but now can also hedge its exposure through the indices. [cite])

²⁴² Any analogy of a market liquidity provider to The Bank of Japan's failed attempt to support the Tokyo Stock Exchange's Nikkei index would also be inappropriate. The Nikkei is an index of shares of 225 companies selected to be representative of the Tokyo Stock Exchange as a whole and thus the price of those shares turns on a multitude of macroeconomic factors, including Japan's financial condition.

²⁴³ See, e.g., Tyler Cowen, *It's Hard to Thaw a Frozen Market*, N.Y. TIMES, Mar. 23, 2008, at BU 5 (asking why, in the context of the subprime crisis, "asset prices don't simply fall enough so that someone buys them and trading picks up again"; and answering: "why seek 'fire sale' prices when you might lose your job for doing so?").

²⁴⁴ Cf. Paul M. Healy & Krishna Palepu, *Governance and Intermediation Problems in Capital Markets: Evidence from the Fall of Enron* 26 (Aug. 15, 2002 draft, available at www.ssrn.com (forthcoming in J. ECON. PERSP.)) (observing that fund manager who estimates a stock is overvalued but does not act on this analysis "and simply follows the crowd" will not be rewarded for foreseeing the problems, "but neither will he be blamed for a poor investment decision when the stock ultimately crashes, since his peers made

averse,²⁴⁵ and the fact that disclosure has become so complex that investors are uncertain how much securities are worth increases the perception, if not reality, of risk.

Furthermore, in markets in which the price of securities falls below the intrinsic value of the assets underlying the securities,²⁴⁶ private investors may not want to risk having to wait until maturity of the securities to profit. This risk is exacerbated if the market value of undervalued securities is still falling because investors then would not even break even on near-term resale of the securities.²⁴⁷ A market liquidity provider—especially one able to wait until maturity, if necessary—is needed to correct these market failures.

It should be noted, however, that a market liquidity provider need not necessarily have to invest government funds, at least at the outset, to correct these market failures. Rather than purchasing securities directly, a market liquidity provider could take a more targeted approach to stabilizing panicked markets by entering into derivative contracts to strip out the elements that the market has the greatest difficulty hedging—in effect, the market’s irrationality element—thereby stimulating private investment. The Obama Administration in the United States presently appears to be considering this type of public-private-partnership approach in its revised financial bailout plan.²⁴⁸ By not actually purchasing securities directly, a market liquidity provider would appear to be

the same mistake”); Stephen M. Bainbridge, *Mandatory Disclosure: A Behavioral Analysis*, 68 U. CIN. L. REV. 1023, 1038 (2000) (discussing how herd behavior may have a reputational payoff even if the chosen course of action fails, and arguing that where “the action was consistent with approved conventional wisdom, the hit to the manager’s reputation from an adverse outcome is reduced”).

²⁴⁵ [cite-SLS]

²⁴⁶ See *supra* note 216 and accompanying text.

²⁴⁷ Another possible explanation for private investor reluctance is provided by Kravitt, *supra* note 16, at [cite] (asking, “Who wants to buy securities that will have to be marked down tomorrow, even if one expects them to be worth more eventually?”).

²⁴⁸ Floyd Norris, *U.S. Bank Bailout to Rely in Part on Private Money*, N.Y. TIMES, Feb. 9, 2009, at A1 (reporting that the revised bailout plan would likely depend in part on private investors, such as hedge funds, private-equity funds, and perhaps insurance companies, buying distressed MBS, with the U.S. Government guaranteeing a floor value to the securities purchased).

taking less investment risk and thus its function may be seen as more politically acceptable.²⁴⁹

C. Addressing Failures Arising from Misalignment

Complexity causes several types of misalignment that can give rise to financial-market failures.²⁵⁰ Consider first misalignment caused by the originate-to-distribute model, which can lead to moral hazard (which, in turn, is said to cause lax lending standards) and collective-action problems.²⁵¹ Because this model is critical to the funding liquidity of banks²⁵² and corporations,²⁵³ this article assumes the model will continue notwithstanding its complexity. The article explores possible solutions on that basis.²⁵⁴

The moral hazard problem arises because the originate-to-distribute model misaligns the interests of the lenders with the interests of the ultimate owners of the loans.²⁵⁵ In theory, separation of origination and ownership should not matter because ultimate owners should assess and value risk before buying their ownership positions.²⁵⁶

²⁴⁹ *Cf. id.* (observing that having the government purchase the distressed MBS securities directly would be a “politically perilous course”).

²⁵⁰ *Cf. supra* note 149 (noting that this article does not cover all types of conflicts that could cause market failure, just those that result from complexity).

²⁵¹ *See supra* notes 30-37 and accompanying text.

²⁵² *See, e.g.*, Joseph R. Mason, “Mortgage Loan Modification: Promises and Pitfalls” (undated Powerpoint presentation to the Federal Reserve Bank of Cleveland at its workshop on “Structured Finance and Loan Modification,” Nov. 20, 2007) (showing that 58% of mortgage liquidity in the United States, and 75% of mortgage liquidity in California, has come from structured finance, which relies on the originate-to-distribute model).

²⁵³ *See* Xudong An, Yongheng Deng & Stuart A. Gabriel, *Value Creation Through Securitization: Evidence from the CMBS Market* 3 (Feb. 18, 2008) (SSRN working paper no. 1095645) (concluding that despite the recent mortgage crisis, securitizing financial assets through the originate-to-distribute model has created value in the financial markets).

²⁵⁴ *Cf.* Lucian Arye Bebchuk, *A New Approach to Corporate Reorganizations*, 101 HARV. L. REV. 775, 776–77 (1988) (grafting a normative analysis onto a positive assumption, in that case taking the existence of corporate reorganizations in bankruptcy law as a given to put forth a suggestion to improve the reorganization process).

²⁵⁵ *See supra* notes 34-35 and accompanying text.

²⁵⁶ *Cf.* Policy Statement on Financial Market Developments, *supra* note 220, at 451-52, 455 (recommending that investors normally make informed decisions about risk, but

Even though lenders are better situated to make this evaluation than the ultimate owners, the latter should take steps to reduce, or to compensate for, this information asymmetry.²⁵⁷ The subprime crisis demonstrates, however, that practice can diverge from theory in this context because of the complexity of disclosure, the tendency of investors to engage in herd behavior, and the possible excessive diversification of risk that undermines any given investor's incentive to monitor and see the big picture.²⁵⁸

One solution to the moral hazard problem caused by this misalignment is to require loan originators to retain some realistic risk of loss.²⁵⁹ This solution, though, would not necessarily apply to mortgage- and other loan-brokers, who sometimes work with banks and finance companies to help make loans to borrowers.²⁶⁰ Because these "brokers" earn a fee by arranging the loans without putting any of their own funds at risk, they have little incentive to rigorously police credit standards.²⁶¹ To the extent mortgage-broker participation causes lending standards to fall, however, that would be a somewhat straightforward "agency-cost" problem for lenders to solve.²⁶²

noting that in the subprime crisis investors over-relied on ratings instead of engaging in their own independent credit analysis because the securities were so complex).

²⁵⁷ *Id.*

²⁵⁸ See *supra* note 40 and accompanying text. Cf. Schwarcz, *Protecting Financial Markets*, *supra* note 3 (examining why investors purchasing mortgage-backed securities failed to properly analyze disclosures or to police behavior of lenders and issuers).

²⁵⁹ *Id.* at ___. [expand by example and further analyze costs and benefits-cite] Cf. International Monetary Fund, *Global Financial Stability Report, Containing Systemic Risk and Restoring Financial Soundness*, at 81, April 2008, <http://www.imf.org/external/pubs/ft/gfsr/2008/01/index.htm> (last visited July 28, 2008) (stating that the originate-to-distribute model creates moral hazard by relieving the originator of any risk of loss once the loan is sold).

²⁶⁰ A mortgage broker markets mortgage loans and brings lenders and borrowers together. BLACK'S LAW DICTIONARY 206 (8th ed. 2004). Compare *Wyatt v. Union Mortg. Co.*, 598 P.2d 45 (Cal. 1979) ("A mortgage loan broker is customarily retained by a borrower to act as the borrower's agent in negotiating an acceptable loan") with 24 C.F.R. § 3500.7(a)(4)-(b) (describing a mortgage broker as a lender's agent).

²⁶¹ Cf. Vikas Bajaj, *Inquiry Assails Accounting Firm in Lender's Fall*, N.Y. TIMES, Mar. 27, 2008, at A1 (describing the "dodgiest mortgages" as resulting, at worst from, brokers marketing risky mortgages "aggressively, [and] sometimes unscrupulously").

²⁶² [Expand this conclusion. cite]

Misalignment caused by the originate-to-distribute model also can create a collective-action problem when the ultimate owners of the loans are widely dispersed. This problem manifests itself most clearly in loan servicing.²⁶³ Theoretically this problem should be able to be alleviated by hiring competent “servicers” to service the loans on behalf of the owners, and indeed typical transactional documentation²⁶⁴ provides for hiring a servicer to act on behalf of the investors who beneficially own the loans.²⁶⁵

In the subprime crisis, however, hiring servicers did not always solve the collective-action problem. Although servicers usually retained power, acting “in the best interests” of the investors in the mortgage-backed securities, to restructure the underlying mortgage loans,²⁶⁶ in practice servicers were reluctant to engage in restructuring. There was uncertainty whether the servicer’s costs of engaging in a restructuring would be reimbursed, whereas all foreclosure costs are reimbursed.²⁶⁷ More significantly, servicers often preferred foreclosure over restructuring because the former is more ministerial and thus has lower litigation risk.²⁶⁸ The litigation risk was exacerbated in the subprime crisis by the fact that, in many cases, cash flows deriving from principal and interest on the mortgages were separately allocated to different investor classes, or “tranches,” of the securities.²⁶⁹ A restructuring that, for example, reduced the interest rate would adversely

²⁶³ See *supra* notes 42-43 and accompanying text.

²⁶⁴ This is usually in the so-called “pooling and servicing agreement.”

²⁶⁵ It is also typical for originators of mortgage loans, or a specialized servicing company such as Countrywide Home Loans Servicing LP, to act as the servicer for a fee. JAMES A. ROSENTHAL & JUAN M. OCAMPO, *SECURITIZATION OF CREDIT: INSIDE THE NEW TECHNOLOGY OF FINANCE* 49-51 (1988) (explaining the general structure of a grantor trust when the originator of asset-backed securities services the pool of assets); Gretchen Morgenson, *Countrywide Is Upbeat Despite Loss*, N.Y. TIMES, Oct. 27, 2007, at C1 (reporting that Countrywide is the nation’s largest loan servicer).

²⁶⁶ Gretchen Morgenson, *More Home Foreclosures Loom as Owners Face Mortgage Maze*, N.Y. TIMES, Aug. 6, 2007, at A1.

²⁶⁷ *Protecting Financial Markets*, *supra* note 3, at ___.

²⁶⁸ *Protecting Financial Markets*, *supra* note 3, at ___.

²⁶⁹ Jon D. Van Gorp, “Capital Markets Dispersion of Subprime Mortgage Risk” 10 (unpublished Nov. 2007 manuscript, on file with author), at 7-8.

affect investors in the interest-only tranche,²⁷⁰ leading to what some have called “tranche warfare.”²⁷¹

The collective-action problem, however, should be able to be managed. Parties should consider, for example, writing underlying deal documentation that sets clearer and more flexible guidelines, and ideally more certain reimbursement procedures, for loan restructuring—especially when such restructuring is superior to foreclosure.²⁷² Investors (and servicers) should prefer foreclosure to restructuring if restructuring merely delays an inevitable foreclosure.²⁷³

Misalignment can also cause failure in the form of fraud. This article has shown that current best-practice monitoring procedures in asset-backed securities transactions are not failsafe because the servicer is not usually independent of the company originating the underlying financial assets.²⁷⁴ An affiliated servicer can manipulate

²⁷⁰ The conflicts among tranches can become even more complicated because CDO and ABS CDO securities sometimes also include prepayment-penalty tranches, and the different tranches “have different priorities relative to one another for the purpose of absorbing losses and prepayments on the underlying subprime mortgage loans.” *Id.* at 8.

²⁷¹ Telephone Interview with Hirsch, *supra* note 40 (describing tranche conflicts as a significant reason why servicers choose foreclosure over restructuring). The term, “tranche warfare,” was originally coined in Kurt Eggert, *Held Up in Due Course: Predatory Lending, Securitization, and The Holder in Due Course Doctrine*, 35 CREIGHTON L. REV. 503, 563 (2002).

²⁷² In the current subprime crisis, of course, the underlying deal documentation is already in place. Because existing documentation cannot be easily renegotiated, the government might consider legislating changes. Any such changes that are subsidized in whole or part by government, however, could foster moral hazard, potentially making future homeowners more willing to take risks when borrowing.

²⁷³ Misalignment also can result in a collective-action problem to the extent the originate-to-distribute model makes the size of any given loan-owner’s investment so small that it deprives owners of the incentive to engage in due diligence and monitoring. MARK ADELSON, *MBS BASICS* (Nomura Sec. Int’l 2006). This article’s proposal to require loan originators to retain some material exposure to risk, however, would help to solve this collective-action problem.

²⁷⁴ See *supra* note 102 and accompanying text.

monitoring in ways that are undetectable unless investors, or their agents, micromanage all uses and sources of cash.²⁷⁵

Misalignment that facilitates fraud can be addressed either by using a servicer independent of the company if there is any doubt of the servicer's integrity, or by allowing investors or their agents to micromanage the uses and sources of cash. Because the servicer of the financial assets effectively manages uses and sources of cash collections from those assets, the most straightforward solution when in doubt of the servicer's integrity is to use an independent servicer.²⁷⁶

In practice, asset-backed securities transactions may evolve in the direction of more frequently using independent, third-party servicers to increase investor comfort.²⁷⁷ This evolution is likely to be gradual because, at least currently, few independent parties have the needed servicing expertise and experience to cost-effectively perform in this capacity.²⁷⁸ Nonetheless, there is evidence that the market is beginning to respond, such as the recent decision by Bank of America to purchase Countrywide Financial Corp., partly in order to gain "greater scale in . . . servicing mortgages."²⁷⁹

²⁷⁵ See *supra* notes 103-107 and accompanying text.

²⁷⁶ It will be interesting also to observe the extent to which investors gain comfort where the company is represented by a large, prominent, and highly respected law firm. The most agreed upon scholarly understanding of the value added by transactional lawyers is that, as repeat players in the transactional world, they add value by renting their good reputation to clients. This thesis of transactional lawyers as "reputational intermediaries" was first advanced in Ronald Gilson, *Value Creation by Business Lawyers: Legal Skills and Asset Pricing*, 94 YALE L. J. 239 (1984). See also Peter J. Gardner, *A Role for the Business Attorney in the Twenty-First Century: Adding Value to the Client's Enterprise in the Knowledge Economy*, 7 MARQ. INTELL. PROP. L. REV. 17, 46-48 (2003); Karl S. Okamoto, *Reputation and the Value of Lawyers*, 74 OR. L. REV. 15, 43 (1995). The rationale is that the high-reputation law firm bonds itself to good performance, losing at least part of its reputation if it fails to perform well. Indeed, a high-reputation law firm adds the greatest relative value when the client does not already have a high reputation.

²⁷⁷ Cf. STRUCTURED FINANCE, *supra* note 50, §4:5 at 4-9 (citing Lloyds & Scottish Fin. Ltd. v. Cyril Lord Carpets Sales Ltd., H.L. (Mar. 29, 1979); People v. Serv. Inst., Inc., 421 N.Y.S.2d 325 (Sup. Court Suffolk County 1979)).

²⁷⁸ See *supra* note 102 and accompanying text.

²⁷⁹ Press Release, "Bank of America Agrees to Purchase Countrywide Financial Corp.," Jan. 11, 2008.

If the market takes steps to correct itself in this manner, there should be no need for regulation requiring the use of independent servicers. Indeed, parties should have the flexibility to decide not to use independent servicers where they trust a servicer affiliated with the company originating the financial assets. There is nothing intrinsically wrong or unusual for parties in business transactions to deal with each other on the basis of trust.²⁸⁰ And some transactions may be beneficial even taking into account the increased possibility of fraud absent an independent servicer.²⁸¹

The potential to ultimately impose regulation might nonetheless be valuable. In the current financial environment, investors may call for independent servicers, but investors tend to have short memories. Experience has shown that once a crisis recedes in memory, they will almost always tend to “go for the gold.”²⁸² There may come a time when regulation, or its threat, is needed to restore market discipline.²⁸³

Finally, misalignment can cause failure when conflicts exist among a firm’s managers, such as when investment analysts resort to simplifying heuristics when

²⁸⁰ Cf. T. Volery & S. Mensik, *The Role of Trust in Creating Effective Alliances: A Managerial Perspective*, 17 J. BUS. ETHICS 987 (1998) (observing that trust plays a crucial role in creating and managing alliances because it reduces complex realities far more quickly and economically than prediction, authority or bargaining).

²⁸¹ Cf. *supra* note 157 and accompanying text (discussing cost-benefit analysis).

²⁸² Larry Light, *Bondholder Beware: Value Subject to Change Without Notice*, BUS. WK., at 34 (Mar. 29, 1993) (“[b]ondholders can—and will—fuss all they like. But the reality is, their options are limited: higher returns or better protection. Most investors will continue to go for the gold.”) (discussing, in the context of but several years after the “Marriott split,” that investors favor higher interest rates over “event risk” covenants once examples of events justifying the covenants have receded in memory, even though they could reoccur). Psychologists label the tendency of people to overestimate the frequency or likelihood of an event when examples of, or associations with, similar events are easily brought to mind as the availability heuristic. Paul Slovic, Baruch Fischhoff & Sarah Lichtenstein, *Facts Versus Fears: Understanding Perceived Risk*, in JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 463, 465 (Daniel Kahneman et al. eds., 1982).

²⁸³ Compare *supra* notes 168-185 and accompanying text.

analyzing highly complex securities²⁸⁴ or manipulate models for their pecuniary advantage.²⁸⁵ This can be addressed by better aligning management compensation incentives with the long-term interests of the firm,²⁸⁶ such as retroactively recovering compensation paid to managers or paying a portion of compensation contingently over time or in the form of equity securities with long-term lock-down constraints on selling the securities.²⁸⁷ Better alignment of compensation and firm interests also would have mitigated a similar problem of misalignment in hedge funds; certain losses of institutional investors in the subprime crisis appear to have resulted from losses in CDO investments by controlled or managed hedge funds.²⁸⁸ Because managers of those hedge funds were paid according to hedge-fund industry custom, in which “fund managers reap large rewards on the upside without a corresponding punitive downside,”²⁸⁹ they had significant conflicts of interest with the institutions owning the funds.

Firms have incentives, and are in a better position than government regulators, to determine how best to align their long-term interests with manager compensation.

Alignment is difficult to achieve, however, because individual firms that attempt to align

²⁸⁴ See *supra* notes 59-62 and accompanying text.

²⁸⁵ See *supra* notes 71-76 and accompanying text (discussing how investment analysts manipulated VaR modeling).

²⁸⁶ Cf. CRMPG III REPORT, *supra* note 57, at 5 (observing that “more can be done to ensure that incentives associated with compensation are better aligned with risk taking and risk tolerance across broad classes of senior and executive management”). Sections 111(b)(2)(A)-(C) of The Emergency Economic Stabilization Act of 2008 requires, in a limited context, that firms take a more long-term view to compensation to avoid conflicts in the way that managers are paid, receiving high compensations and bonuses for arranging deals or investments that later fail.

²⁸⁷ See *Conflicts and Financial Collapse*, *supra* note 149, at [cite] (examining these compensation alternatives in detail). Cf. Arthur B. Laby, *Differentiating Gatekeepers*, 1 BROOK. J. CORP. FIN. & COM. L. 119, 159-60 (2006), citing Tom Johnson, *The 2005 All-America Research Team*, INSTITUTIONAL INVESTOR, Oct. 1, 2005, at 54, 81 (“Sell-side analysts, for example, are generally not compensated based solely on investment performance. Buy-side firms rate, and presumably pay, sell-side analysts based on factors other than performance, including timeliness of information, responsiveness, innovation, and comprehensibility of research reports”).

²⁸⁸ Kate Kelly, Serena Ng & David Reilly, *Two Big Funds At Bear Stearns Face Shutdown—As Rescue Plan Falts Amid Subprime Woes, Merrill Asserts Claims*, WALL. ST. J., June 20, 2007, at A1.

incentives will be disadvantaged in their ability to compete for the best managers.²⁹⁰ Regulation may well be needed to help resolve this collective-action problem.²⁹¹

This Part III has analyzed how market failures resulting from complexity can be minimized. Many failures can be alleviated without regulation,²⁹² and indeed regulation itself can have unintended, and often adverse, consequences.²⁹³ Nonetheless, there are areas in which regulation—or at least the threat of regulation—is desirable, if not necessary. Besides helping to resolve the collective-action problem discussed above,²⁹⁴ regulation can limit the extent to which an investor crisis of confidence causes markets to collapse by allowing portfolio disclosure as an alternative to marking to market.²⁹⁵ Regulation also can speed the adoption of desirable market changes—for example, by eliminating the time needed for existing contracts to be replaced.²⁹⁶ Similarly, as the lessons of the subprime crisis fade in the memories of investors, regulation might be needed to limit undue future reliance on mark-to-model valuation²⁹⁷ and to ensure that investors give appropriate consideration to the need for independent third-party servicing²⁹⁸ and avoid inappropriate exclusive reliance upon credit ratings.²⁹⁹ An important question, addressed below, is whether such regulation should be rules-based or principles-based.

D. Should Regulation be Rules-based or Principles-based?

²⁸⁹ James Surowiecki, *Performance-Pay Perplexes*, NEW YORKER, Nov. 12, 2007, at 34.

²⁹⁰ *Conflicts and Financial Collapse*, *supra* note 149, at [cite].

²⁹¹ *Id.*

²⁹² This article proposes, for example, that servicing agreements be drafted with clearer and more flexible servicing guidelines, that investors demand the use of independent third-party servicers, and that investors also require that loan originators retain a realistic risk exposure.

²⁹³ *See, e.g., supra* notes 117-119 and accompanying text.

²⁹⁴ *See supra* notes 290-291 and accompanying text.

²⁹⁵ *See supra* note 201 and accompanying text.

²⁹⁶ *See supra* note 265 and accompanying text.

²⁹⁷ *See supra* note 168 and accompanying text.

²⁹⁸ *See supra* notes 282-283 and accompanying text.

²⁹⁹ *See supra* note 59 and accompanying text.

The argument in favor of regulation based on principles is that investment securities and financial markets constantly change, often unpredictably,³⁰⁰ and principles-based regulation is better suited to govern changing scenarios.³⁰¹ Rules could be overly constraining or could simply lose their effectiveness.³⁰²

Perhaps for this reason, the United Kingdom's Financial Services Authority (FSA) is moving to more of a principles-based approach.³⁰³ Similarly, in the United States, the Financial Accounting Standards Board (FASB) is shifting GAAP from rules-based to more principles-based³⁰⁴ and, to some extent, the emphasis of supervisory practices likewise appears to be shifting to a more principles-based approach.³⁰⁵

Principles-based regulation, however, is most appropriate in an “interpretive community” in which “the interpretive assumptions and procedures are so widely shared” by the regulator with the regulated parties (in our case, market participants) that the regulatory principles bear “the same meaning for all.”³⁰⁶ Without such shared assumptions and procedures, regulated parties will be unable to predict the consequences of their

³⁰⁰ Cf. JOHNSON, JEFFERIES, & HUI, *supra* note 125, at ___ (noting that fluctuations in evolving financial markets are difficult to model ex ante because previously observed statistical patterns do not always continue).

³⁰¹ Cristie L. Ford, *New Governance, Compliance, and Principles-Based Securities Regulation*, 45 AM. BUS. L.J. 1, 2 n. 8 (2008) (citing the SEC's recent establishment of a principles-based definition and disclosure requirements for asset-backed securities).

³⁰² *Id.* at 60 (“Principles-based regulation and outcome-oriented regulation are responses to a visceral recognition that traditional, rule-oriented legal regimes are limited in their ability to deal with some broader organizational and cultural problems”).

³⁰³ FINANCIAL SERVICES AUTHORITY, PRINCIPLES-BASED REGULATION, FOCUSING ON THE OUTCOMES THAT MATTER (Apr. 2007).

³⁰⁴ Financial Accounting Standards Board, *Proposal for a Principles-Based Approach to U.S. Standard Setting*, File Reference No. 1125-001 (Oct. 21, 2002), available at http://www.fasb.org/proposals/principles-based_approach.pdf (last visited Aug. 27, 2008); Financial Accounting Standards Board, *FASB Response to SEC Study on the Adoption of a Principles-Based Accounting System* (July 2004), available at http://www.fasb.org/response_sec_study_july2004.pdf (last visited Aug. 27, 2008).

³⁰⁵ CRMPG III REPORT, *supra* note 57, at 137.

³⁰⁶ Julia Black, *Using Rules Effectively*, in REGULATION AND DEREGULATION 95, ___ (C. McCrudden ed., 1999).

actions.³⁰⁷ Regulators need information from industry to remain relevant, just as industry needs information from regulators to remain compliant.³⁰⁸ To this end, “[m]any in the securities industry are calling for more principles-based regulation, linked with prudential oversight, to foster a consultative relationship between regulators and industry participants.”³⁰⁹

This suggests a potential dilemma: as investment securities and financial markets become increasingly internationalized and more complex, making principles-based regulation more attractive as a means to adapt given principles to different legal systems, it will become increasingly harder for regulators and market participants to act together as a community. That, in turn, will make principles-based regulation less effective.³¹⁰ Regulators and market participants will have to remain cognizant of this limitation.³¹¹

IV. CONCLUSIONS

As the subprime crisis has dramatically illustrated, complexity can be both beneficial and harmful. It is beneficial to the extent it adds efficiency and depth to financial markets and investments, such as by satisfying investor demand for securities that more closely meet their investment criteria and by facilitating the transfer of risk to those who prefer to hold it.³¹² But it is harmful to the extent it triggers the market failures

³⁰⁷ Cf. comments of Eilis Ferran, Professor of Company and Securities Law, University of Cambridge Faculty of Law, at the University of Cambridge Conference on Principles v. Rules in Financial Regulation, April 12, 2008 (expressing concern that, because its strategy is to enforce on the basis of principles alone, the FSA’s assurance that firms will find it possible to predict the consequences of their actions will be “just empty words”).

³⁰⁸ E-mail from Cristie Ford, Assistant Professor, University of British Columbia Faculty of Law and author of *New Governance, Compliance, and Principles-Based Securities Regulation*, 45 AM. BUS. L.J. 1 (2008), to the author (Apr. 19, 2008).

³⁰⁹ Elizabeth Derbes, “The Subprime Crisis: U.S. Regulatory Responses and Lessons Learned” ¶ V.B.3 (2008 unpublished manuscript, on file with author).

³¹⁰ [consider providing examples from regulation proposed in this article. cite]

³¹¹ [cite—expand and develop this]

³¹² See *supra* notes 6-11 and accompanying text.

described in this article, “mak[ing] crises inevitable.”³¹³ Ultimately it is necessary to find a balance through market adaptation and, when needed, regulation.

This article attempts to strike that balance. To this end, the article first examines the ways in which complexity can cause markets to fail. For example, the complexities of the assets underlying investment securities and the means of originating those assets can lead to a failure of lending standards. The complexities of investment securities themselves can lead to a failure of investing standards and financial-market practices by impairing disclosure, obscuring the ability of market participants to see and judge consequences, and making financial markets more susceptible to financial contagion and to fraud. And the complexities of modern financial markets can exacerbate these market failures. Because these complexities are characteristic of complexities in engineering systems with nonlinear feedback and the failures themselves are characteristic of failures in those systems, the article’s analysis in part takes a law and engineering approach.

That approach reveals that complexity not only makes it impossible to predict how future financial crises will arise but also makes it more likely that regulation can lead to unintended, and often adverse, consequences.³¹⁴ To help solve this regulatory dilemma, the article proposes, among other possible solutions, creation of a market liquidity provider of last resort having the power to invest in securities of panicked markets or, as circumstances warrant, to hedge irrational elements of a market panic, thereby stimulating private investment in these securities.³¹⁵ By so stabilizing market prices—especially when those prices fall below the intrinsic value of the securities, such as occurred in the subprime crisis³¹⁶—such a market liquidity provider would address the

³¹³ BOOKSTABER, *supra* note 70, at 5.

³¹⁴ [Consider commenting, as applicable, on regulation proposed when this article goes to press. cite]

³¹⁵ *See supra* notes 242-249 and accompanying text (discussing market failures that deter private investment and how hedging can re-stimulate that investment).

³¹⁶ This article indeed proposes, to minimize moral hazard, that a market liquidity provider of last resort should consider providing market liquidity *only* when it believes it can profit or at least break even. A market liquidity provider’s mission should be solely to correct market failures. *See supra* notes 233-235 and accompanying text.

very consequences of market failure, dampening the over-amplification of marking to market that can lead to market collapse and reducing systemic risk by de-coupling the chance that a failure in one market will trigger a failure in other markets.

This solution takes inspiration from engineering design in which de-coupling systems through modularity helps to reduce the likelihood that a failure in one part of a complex system will trigger a failure in another part. Using modularity to reduce danger from complex systems derives from chaos theory, which recognizes that failures are almost inevitable in complex systems and that successful systems are those in which the consequences of a failure are limited. A market liquidity provider would work to limit the consequences of inevitable market failure by providing functional “modularity.”

This article’s conception of a market liquidity provider of last resort for financial markets goes substantially beyond the U.S. Federal Reserve’s traditional focus as a lender of last resort to financial institutions. The additional focus on markets is needed to reflect the increasing shift of corporate financing from banks and other financial institutions to financial markets.³¹⁷ Furthermore, because its mission is to correct market failure, a market liquidity provider should be able to invest profitably and still stabilize market prices.³¹⁸ This should not create a taxpayer burden; and any moral-hazard costs are likely to be minimal, or at least substantially lower than the moral-hazard costs created by a lender of last resort to institutions.³¹⁹

The solutions offered by this article, along with the “law and engineering” approaches introduced, represent important first steps in helping to mitigate some of the harmful consequences of complexity without impairing the viability and importance of modern capital markets. Future study of complexity in financial markets may further

³¹⁷ The Obama Administration’s recently-proposed revised financial bailout plan appears to recognize this reality. *See supra* note 248 and accompanying text (observing that government backing of the market for distressed MBS is an important element of this plan).

³¹⁸ *See supra* notes 233-234 and 243-244 and accompanying text.

³¹⁹ *See supra* notes 231-234 and accompanying text.

benefit from ongoing engineering research, where a variety of modeling approaches are being employed to understand nonlinear interactive patterns.³²⁰ Any regulation based on that research should nonetheless be approached with caution. An analysis based on models is dependent on the underlying assumptions, and we do not yet know enough about financial markets to be certain of the assumptions.³²¹

³²⁰ See, e.g., Burkett et al., *supra* note 117 (discussing research in ecosystem engineering that uses a variety of modeling approaches to understand nonlinear patterns). For example, scientists have been using models to analyze lake eutrophication, a process in which excess nutrients (such as phosphorous created by pollution) within the lake stimulate growth of aquatic plants, in turn causing rapid and cascading changes that ultimately deplete the lake's dissolved oxygen. *Id.* at 360. Traditional linear models can significantly overstate acceptable phosphorous levels because such models disregard nonlinearities such as threshold and feedback effects. *Id.* These are the same types of nonlinearities that exist in financial markets.

³²¹ Cf. 10th William Taylor Memorial Lecture, *Credit Markets and the Economic Crisis: Hearing Before the S. Comm. on Banking, Housing and Urban Affairs*, available through Federal News Service (Oct. 16, 2008) or at http://banking.senate.gov/public/_files/LUDWIGSenateBankingHearingRecord_TaylorLecture_Final_092508.pdf (Oct. 16, 2008) (statement of Eugene Ludwig, Chief Executive Officer, Promontory Financial Group) (stating that “it is widely accepted” now that the subprime mortgage securitization models used by rating agencies and other market participants relied on “insufficient data and faulty assumptions”); Karl S. Okamoto, *After the Bailout: Regulating Systemic Moral Hazard* 23 (Oct. 30, 2008 unpublished draft manuscript, on file with author) (observing that underlying the subprime financial crisis “was an enormous [and unjustified] faith in the market’s ability to analyze and measure risk”). Investor panic leading to the subprime crisis may have been triggered, ironically, by incorrect modeling assumptions. Cf. *supra* notes 87-88 and accompanying text (observing that, in the subprime crisis, the assumptions underlying valuation models for CDO and ABS CDO securities turned out to be wrong, triggering investor panic).