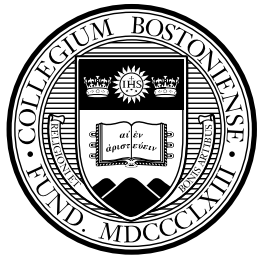
Systemic Risk: An Exploration of the Late 2000s Financial Crisis and Consequences of Government Mismanagement

Author: Kevin J. Moran



SYSTEMIC RISK: AN EXPLORATION OF THE LATE 2000S FINANCIAL CRISIS AND CONSEQUENCES OF GOVERNMENT MISMANAGEMENT

by

Kevin Moran

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Advisor: Prof. Robert G. Murphy

Signature: _____

Second Reader: Prof. Jeffery Pontiff

Signature: _____

IS Thesis Coordinator: Prof. Hiroshi Nakazato

Signature: _____

ABSTRACT

The majority of scholarship surrounding the late 2000s financial crisis explores the enabling factors that contributed to the subprime bubble and caused it to burst. This study's purpose is to evaluate systemic risk and the near collapse of the financial sector in 2008. Several factors, including derivatives innovation, the rise of a parallel banking industry, and the securitization boom, heightened systemic fragility. I add to financial contagion literature by constructing a stochastic game theory model of institutional decision-making under the auspices of a severe liquidity shortage. Moreover, I will employ this model to evaluate the government's regulatory program during the crisis. I find that the government's ad hoc interventions and non-interventions significantly contributed to the atmosphere of uncertainty and exacerbated the crisis' ill effects. I go on to evaluate the Dodd-Frank Act in light of those conclusions and suggest an alternate method of financial reform.

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1.1

INTRODUCTION

The notion of risk has taken on new meaning for many in light of the recent—and some would argue ongoing—financial crisis. The crisis and ensuing recession has led some pundits to question the societal value of Wall Street and the moral constitution of bankers. However, the errors in judgment that allowed for this stunning meltdown to occur can be traced to two distinct developments within the finance industry over the past 30 years and the government's inability to effectively regulate them. Derivatives innovation and the rise of a parallel banking industry have linked the most significant financial institutions in a variety of ways. I propose to conduct a study of the implications of increasingly correlated financial firms and the regulatory conditions in which they operate.

Systemic risk theory attempts to quantify the risk that a shock to the financial system significantly deteriorates its crucial functions and threatens to destabilize the greater economy. Over the past thirty years, radical innovation has transformed the finance industry and the government's relationship with it. During this time, the emergence of derivatives markets and a shadow (or *parallel*) banking system has significantly altered the ability of managers and regulators to understand risk. Though these apparatus have expanded the provision of liquidity and provided vehicles for risk management, derivatives and

shadow banking have also transformed conceptions of financial fragility. My goal is to explore whether these developments have compromised the government's ability to effectively regulate the financial industry.

By designating a workable definition of systemic risk, I hope to develop a model that better characterizes the realities of financial instability and reveals the shortcomings of government oversight and intervention. Though there are many scholarly conceptions of this illusive notion, William C. Hunter and David Marshall, two Federal Reserve economists, have established a thorough framework that will provide the basis for my research. They suggest that systemic risk must originate in the "process of financing;" that is, they assert that "systemic risk would not be present if all firms were purely financed internally."[1] Moreover, a systemic crisis involves a severe degree of contagion, a sharp reduction of liquidity, implies considerable *real* economic consequences, and demands a policy response. By evaluating firms' decisions through this analytical prism, I intend to decipher the events that lead to instances of systemic instability.

Because the recent financial collapse has not been entirely resolved, I have an auspicious opportunity to evaluate different regulatory responses. In particular, I endeavor to evaluate government action in the heat of the crisis as well as reform procedures in the United States Congress' Dodd-Frank Act. By examining the prospects for federal oversight and significant regulation in the

[1] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives, Systematic Risk and Central Banking: A Review of Recent Developments," a Federal Reserve Bank of Chicago Working Paper WP 99-20.

financial sector, I will evaluate these initiatives' ability to diminish the impact of systemic risk. I hope to produce an applicable, game theory stochastic model of financial contagion that will provide a context for firm and industry-wide decisions during a crisis. This model will rely heavily on the work of Roger Lagunoff and Stacey Schreft (1998). I will expand their simple investor-entrepreneur model to explore significant financial institution's financing processes and asset portfolios, as well as the role of government interventions on institutional decision-making.

1.2

WHAT IS SYSTEMIC RISK?

The notion of *systemic* risk implies widespread breakdowns across an entire system. Scholars typically present three courses of understanding in regard to systemic risk. Frederic Mishkin, an economist and former Federal Reserve Board member, asserts that systemic risk is "the likelihood of a sudden, usually unexpected, event that disrupts information in financial markets, making them unable to effectively channel funds to those parties with the most productive investment opportunities."[2] This definition addresses the risk of a macro-level shock disrupting the viability of financial markets; in this case, *systemic* "refers to an event having effects on the entire banking, financial, or economic system, rather than just one or a few institutions."[3] It does not specify the depth of interaction or means of transmission between intermediaries, institutions, and other units.

A stricter definition, here provided by the 2001 G10 Report on Consolidation in the Financial Sector, allows that systemic risk is the "risk that an event will trigger a loss of economic value or confidence in a substantial portion of the financial system that is serious enough to quite probably have significant

[2] Frederic Mishkin, "Asymmetric Information and Financial Crises: A Historical Perspective." In *Financial Markets and Financial Crises,* edited by R. Glenn Hubbard, 69–108. Chicago: University of Chicago Press. 1991.
[3] Philip Bartholomew and Gary Whalen, "Fundamentals of Systemic Risk," in *Research in Financial Services: Banking, Financial Markets, and Systemic Risk*. (JAI: Greenwich, CT), 1995.

adverse effects on the real economy."[4] This conception parallels that of the Bank for International Settlements (BIS), which contends that systemic risk is "the risk that the failure of a participant to meet its contractual obligations may in turn cause other participants to default with a chain reaction leading to broader financial difficulties."[5] These definitions illustrate the domino chain-reaction effect of financial exposure; in this understanding, merely one institutional failure threatens to destabilize the system. In addition, these perceptions "emphasize correlation with causation, and they require close and direct connections among institutions or markets."[6]

The third concept of systemic risk very closely resembles the second in regard to financial contagion, but allows for less direct institutional connections and more market uncertainty. According to Kaufman and Scott, "when one unit experiences adverse effects from a shock—say the failure of a large financial or non financial firm—that generates severe losses, uncertainty is created about the values of other units potentially subject to adverse effects from the same shock."[7] Perceived weaknesses—real or imagined—in institutions with exposure to the failure can result in abounding withdrawals. In the face of market uncertainty, investors and corporations will 'run to quality' from all units that appear potentially at risk. At a certain point, "common-shock contagion appears indiscriminate, potentially affecting more or less the entire universe and

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[4] Group of Ten. 2001. "The G10 Report on Consolidation in the Financial Sector."
[5] Bank for International Settlements, *64th Annual Report*. Basel, Switzerland, 1994.
[6] George Kaufman and Kenneth Scott, "What is Systemic Risk, and Do Bank Regulators Retard or Contribute to It?" in the *Independent Review*, 2003.
[7] Kaufman and Scott, "What is Systemic Risk?" 2003.

reflecting a general loss of confidence in all units."[8] This conception of systemic risk emphasizes the unavailability of information regarding risk exposures and credit lines. Known as *reassessment* or *common* shock, this scenario involves liquidity freezes and represents correlation with *indirect* causation (as opposed to direct "domino" causation in the second formulation).

Part 1—A Workable Definition

William C. Hunter and David Marshall present five general elements that should characterize a reasonable model of systemic risk. First, they assert that systemic risk follows from the notion that not all firms are financed internally; that is, the "capital needed by a firm is provided by investors outside of the firm."[9] Thus, systemic risk originates in and is a characteristic of the financial markets. Further, Hunter and Marshal suggest that systemic crises contain some sort of contagion, wherein problems in one institution threaten insolvency in other institutions (some of which may be otherwise healthy). They also contend that systemic crises will involve a loss of investor confidence. This often results in a liquidity shortage and credit crunch, as firms and individuals lose confidence in one another. Hunter and Marshall's framework also addresses the "substantial real costs" of systemic crises, which include "losses to economic output and/or reductions in economic efficiency."[10] Finally, they argue that systemic crises

[8] Kaufman and Scott, "What is Systemic Risk?" 2003.
[9] George Kaufman and Robert R. Bliss (2006): "Derivatives and Systemic Risk: Netting, Collateral, and Closeout" in Journal of Financial Stability 2 (2006).
[10] Kaufman and Bliss (2006).

demand a policy response. Addressing systemic crises can prove difficult (in this form or any) because they seem to arise spontaneously and with little warning. By employing this evaluative framework, I have selected what I deem to be the most relevant and explanatory delineation of systemic risk.

Darryll Hendricks, of the PEW Research Center's Financial Reform Project, defines systemic risk as "the risk of a phase transition from one equilibrium to another, much less optimal equilibrium, characterized by multiple self-reinforcing feedback mechanisms making it difficult to reverse."[11] By considering other arenas where systemic stability is studied (epidemiology and evolutionary biology, for example), this scientific definition allows for theoretical analysis of the phenomenon and thus will be the definition used in this paper. Hendricks adds that individuals will respond similarly to systemic events: they will act rationally to save themselves but in doing so worsen the situation. In this way, systemic events tend to be characterized by "contagion, hoarding, and flight."[12] In Wall Street vernacular, instances of systemic risk are characterized by extreme market volatility, severely diminished liquidity, sharp credit squeezes, and the threat of widespread insolvency.

Hendricks asserts that every financial crisis consists of some combination of three different elements: a bank run, a market failure, and an infrastructure collapse. In a prototypical bank run, confidence in an institution erodes to the extent that depositors demand restitution of their deposits. In order to meet

[11] Daryll Hendricks (2009): "Defining Systemic Risk." The Pew Financial Reform Project, 2009.
[12] Hendricks (2009): "Defining Systemic Risk."

these obligations, a bank must sell off illiquid assets at significantly depressed prices. When those assets hit markets at depressed values, the public views them as 'toxic' and immediately associates exposure to 'toxic' assets as a bellwether for an unhealthy balance sheet, which stigmatizes other banking institutions. This self-aggrandizing process was especially evident following the collapse of Lehman Brothers in 2008, when its creditors withdrew repo funding[13] and it was unable finance day-to-day operations. As Lehman went under, analysts and investors began to question the solvency of Morgan Stanley and Goldman Sachs, simply because their exposure to seemingly toxic assets was deemed to be similar to Lehman's[14]. The bank run aspect of financial crises is an important aspect of systemic risk.

For a market failure to occur, the market must misprice an entire asset class. As expectations come crashing down, that asset class dramatically loses value, which forces institutions to rapidly reduce their exposure and cover collateral margins. The ensuing sell-off can drag other asset classes into the downward spiral of distressed values, which reinforces the effects of the initial bubble burst. Excessive leverage and inadequate risk models inevitably contribute to the effects of a market collapse.[15] While the housing market bubble was the chief agent of market failure in 2008, the mortgage backed security and

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[13] A *repo* is a sale-and-repurchase agreement in which an institution sells the legal ownership of a security to a 'creditor' overnight so as to finance day-to-day operations and long positions. At term the borrowing institution repurchases the security, which basically equates the transaction to a cash loan.

[14] In this case, the analysts' concerns were justified.

[15] Hendricks, "Defining Systemic Risk."

collateralized debt obligation securitization and re-securitization process perilously exacerbated the effects of a market downturn. By transferring immeasurable amounts of risk across the banking system, the web of mispriced MBS/CDO entanglement contributed to the 'bank run' contagion.

According to Hendricks, systemic risk also threatens the "integrity of market mechanisms."[16] A violent downturn could cause the market's infrastructure to completely and utterly fail; under the stress of extremely high volume, clearance and settlement systems will cease to process trades—instantly suspending liquidity. During the "flash crash" on May 6, 2010, mutual fund manager Waddell & Reed's models prompted a huge sell-off in futures contracts, which caused the stock market to drop 600 points instantaneously. As a result, algorithms at high-volume shops around the world went berserk and executed millions of trades within milliseconds of the drop. At brokerages in financial centers, extraordinary volume threatened to overwhelm the capacity of clearance and settlement systems. Without these back-end processors, brokers would be unable to handle client trading and markets would cease to function for practical purposes. If highly buttressed brokerage systems were to fail, it is reasonable to assume that exchange mechanisms would also wilt under the strain of unprecedented volume. This scenario would be akin to an infrastructure failure—both exchange (like the NYSE, CME, and LIFFE) and OTC trading[17] would collapse.

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[16] Hendricks, "Defining Systemic Risk."

[17] *OTC*—or 'over the counter'—trading of financial instruments occurs directly between two counterparties. There is no exchange mechanism for the purpose of facilitating trades.

Scholars often make a distinction between rational, information-based, and causal systemic risk and non information-based, irrational, and purely contagious systemic risk.[18] The former allows that investors, depositors, and market participants have the ability to differentiate between healthy and toxic entities on the basis of fundamental information. Irrational contagion, on the other hand, "does not differentiate among parties, affecting solvent as well as insolvent parties, and is likely to be both broader and more difficult to contain."[19] However, "the danger that a failure of one financial business may infect other otherwise healthy businesses,"[20] is not unique to one conception of systemic risk or another. The distinction between direct, rational contagion and common-shock irrational contagion is at best fuzzy, as rational contagion often begets irrational systemic risk. Thus, systemic risk is an ambiguous and abstract notion, which makes it difficult to concretely define. The three conditions of systemic instability, the three formulations of systemic risk, and the degrees of rationality in a crisis should be considered as adaptable delineations. Not every crisis or collapse will conform rigidly to one set of characteristics and most cases of instability will be some combination of the factors explored.

[18] Kaufman and Scott, "What is Systemic Risk?" 2003.
[19] Kaufman and Scott, "What is Systemic Risk?" 2003.
[20] E.A.J. George (1998): "The New Lady of Threadneedle Street" in Governor's Speech, Bank of England. London, February 24, 1998.

Part 2—Sources of Systemic Risk

Prior to many systemic crises, financial markets and macroeconomic variables seem normal. It is exceptionally important to develop a framework that recognizes "financial fragility."[21] According to Hunter and Marshall, there are five distinct sources of systemic risk (and consequential financial instability). I endeavor to explore these sources and their relationship to a functional model of systemic risk. Such a model should account for the possibility that a "small shock can induce widespread difficulties in obtaining financing (especially short-term liquidity), resulting in a large decline in [optimum] economic activity."[22]

For many economists, excessive leverage is the chief symptom of systemic risk. In Charles Kindleberger's book *Manias, Panics, and Crashes*, he attributes cases of financial instability to the "excessive piling on of debt".[23] Due to intense industry competition and governmental regulation, financial firms increasingly finance capital activities with debt liabilities. When an entire industry operates under the auspices of extreme leverage, an idiosyncratic event "can induce multiple simultaneous corporate defaults."[24] By risking more in order to achieve higher returns, firms inherently deviate from the principle of shareholder value maximization. Some critical pundits cite exorbitant compensation packages as the impetus for such imprudent risks. Though compensation packages that

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[21] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives, Systematic Risk and Central Banking: A Review of Recent Developments," a Federal Reserve Bank of Chicago Working Paper WP 99-20.
[22] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives," etc.
[23] Charles P. Kindleberger (1978): *Manias, Panics, and Crashes*. London: MacMillan.
[24] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives," etc.

encourage short term profitability are certainly culpable, a more insidious explanation involves ill-considered federal policy.

It is possible that the choice to bear excessive leverage is an entirely rational managerial decision. A comprehensive government safety net "may be an externality that drives a wedge between the privately optimal debt level and the debt level that is optimal for society as a whole."[25] The Federal Reserve's lender-of-last-resort capability "could induce excessive risk-taking and excessive indebtedness under the presumption that the lender will step in during a liquidity crisis and provide the needed liquidity to the system."[26] If senior bankers believe that the government will step in during a crisis, they have less incentive to ensure maintenance of an appropriate leverage ratio. In this case, the federal government (and by proxy taxpayers) bears the cost of a contagious systemic event.

Hunter and Marshall's third source of systemic risk involves counterparty interconnectedness. They argue that "an institution has both direct exposure to the creditworthiness of its direct counterparties, and indirect exposure to the creditworthiness of its counterparties' counterparties, and so on."[27] By this reasoning, an institution can be susceptible to the credit risk of an entity it has no direct exposure to. Both derivatives innovation and shadow banking relationships have increased the number and thickness of linkages between financial institutions. Though Hunter and Marshall indicate that imperfect

[25] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives," etc.
[26] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives," etc.
[27] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives," etc.

information regarding counterparty exposures should be factored into risk management, measuring the credit risk of one's counterparties is nearly impossible in an age of anonymous trading and the "Chinese wall"[28] of the industry.

Many theorists also believe that sudden liquidity shortages often prompt systemic crises. In this conception, broker dealers are the main liquidity providers in financial markets. Any number of idiosyncratic events can cause one or many of the broker dealers to withdraw liquidity, which can "lead to a chain of defaults that freeze an entire market."[29] This theory, however, applies only as a result of institutional failure; it is one of the repercussions of a systemic crisis—not an antecedent. While a liquidity crisis will certainly dry up market confidence and may lead to one or more defaults, it is less a source of systemic risk and more a product of it.

In their fifth source of systemic risk, Hunter and Marshall invoke economic game theory in the description of coordination occurrences. Though rare, scenarios where game theory coordination can be optimal are often extremely fragile. As chronicled in Roger Lowenstein's book *When Genius Failed*, the 1998 consorted bail out of Long Term Capital Management, a hedge fund that faced an extreme liquidity shortage as a result of extraordinary market movements against its positions. As LTCM's liquidity situation became

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[28] *Chinese Wall:* this term describes the information barrier that prevents conflicts of interest within financial services firms; it separates those with material information from those who make investment decisions.

[29] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives," etc.

increasingly bleak, several of its counterparties "explored the possibility of mutually beneficial alternatives to default."[30] Instead of letting the fund go under, the group (led by JPMorgan, Merrill Lynch, and Salomon Smith Barney) agreed to recapitalize LTCM with $300 million dollar injections apiece.[31] The entire consortium included 14 entities; the recapitalization totaled $3.625 billion. According the Hunter and Marshall, "absent this coordination, the rational decision for each individual creditor would have been to refrain from providing liquidity altogether."[32]

Hunter and Marshall also extend their coordination analysis to include the Diamond-Dybvig model of bank runs. The model stipulates that banks runs can occur when entities employ short-term debt to finance long-term assets. If one lender does not expect any of its peers to extend liquidity, it may be the "lender's best response to refuse to roll over its loans even if the firm would be solvent if all loans were rolled over."[33] Thus, an otherwise viable firm that faces a grievous liquidity crisis can be forced into insolvency. Hunter and Marshall liken this phenomenon to the Asian crisis of 1997, wherein the "flight of foreign short-term capital was analogous to a Diamond-Dybvig bank run."[34] Such a coordination failure is an ominous and relevant source of systemic risk.

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[30] Alan Greenspan and Robert. E. Rubin, Arthur Levitt, and Brooksley Born (1999): "Hedge Funds, Leverage, and the Lessons of Long-Term Capital Management," a *Report of the President's Working Group on Financial Markets*.
[31] Société Générale pledged $125 million, while Lehman Brothers and Paribas pledged $100 million.
[32] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives," etc.
[33] Douglas W. Diamond and Philip H. Dybvig (1983): "Bank Runs, Deposit Insurance, and Liquidity" in *The Journal of Political Economy.* Chicago: University of Chicago Press.
[34] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives," etc.

The implications of systemic crises can be likened to the speedy contagion of an infectious disease epidemic. The banking system is an interconnected web of interbank deposits, loans, and payment system clearings, which is also geometrically linked through service of the same deposit or loan markets.[35] An adverse shock at what Hendricks calls a 'systemically significant institution' or SSI[36] could result in the transmission of that shock to other institutions on the transmission chain. Though firms "with sufficient capital to absorb the transmitted losses will remain solvent, they may be weakened"[37] and this balance sheet weakness (and expectation of toxic exposure) can translate into a lack of confidence. Moreover, the extent to which a firm leverages its assets has a direct correlation to its exposure to systemic shock; the more debt on an institution's balance sheet, the easier it is for an adverse occurrence to drive that institution into insolvency. Moreover, the recent growth and development of what has become known as the *shadow banking industry* has thickened the connections between depository commercial banks and other financial intermediaries such as investment banks, hedge funds, and money market funds. Innovation in derivatives markets has paralleled the growth of shadow banking and also contributed to the interconnectedness of financial institutions. As financiers, traders, and bankers have explored increasingly complicated means of financing they have developed financial products and institutional relationships that increase systemic susceptibility.

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[35] Kaufman and Scott, "What is Systemic Risk?" 2003.
[36] Hendricks, "Defining Systemic Risk." 2009.
[37] Kaufman and Scott, "What is Systemic Risk?" 2003.

Successful explorations of systemic risk must address a wide variety of factors. First it is important to undervalue the differentiation between chain reaction and common shock systemic risk: for all relevant purposes any systemic event will involve some blend of chain reaction collapse and reassessment irrationality. Moreover, it is extremely important to evaluate the menace of systemic shocks. In the liquidity crisis of 2007-2009, "all securities became highly correlated as all investors and funded institutions were forced to sell high quality assets [at depressed prices] in order to generate liquidity."[38] This precipitous scenario resulted in the financial system's susceptibility to "[a] supply of poorly underwritten loans and structured securities," which ultimately led to the failure of a group of institutions and "collapse of entire markets."[39] Though systemic risk cannot be easily quantified, it can result in a contagious chain reaction of institutional collapse, the near perfect correlation of seemingly unrelated financial instruments, and pervasive market irrationality.

[38] Zoltan Pozsar, Tobias Adrian, et. al., "Shadow Banking," (Federal Reserve Bank of New York Staff Reports: No. 458, July 2010), pg. 4.
[39] Poszar, Adrian, et al. "Shadow Banking," pg. 4.

1.3

DERIVATIVES INNOVATION

An overwhelming impetus to specialize security risk spawned widespread derivatives innovation in the 1980s. Since then, Wall Street analysts have continued to design complex financial instruments at a breakneck pace. In *The Way into any Market*, David Shirreff contends that "derivatives markets have turned the world's capital markets into a global Olympic Games—every day, barriers are broken and records set."[40] A derivative product derives its value "in whole or in part from the performance of an underlying asset—including securities, currencies, commodities, rates, or indices of asset values."[41] Analysts have constructed many of these products using the four fundamental instruments: forwards, futures, options, and swaps. Intermediaries trade derivatives over-the-counter (OTC) and on market exchanges such as the Chicago Mercantile Exchange. Non-financial and financial firms alike employ derivatives as cost-effective and flexible vehicles to hedge against unfavorable market movements.

The sheer variety of derivatives available allows firms to manage unique risks or take speculative positions. Forwards are contracts between two parties to

[40] David Shirreff (1983): "The Way into any Market," in *Euromoney*, Nov. 1983, pp. 60.
[41] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).

buy or sell a specified asset at a future date for a price agreed upon beforehand. Forwards typically trade over-the-counter. Futures contracts are nearly identical to forwards, but trade on an exchange and have interim margin resettlements. These instruments are the simplest derivatives; options and swaps (and their incredibly elaborate progeny) are much more complicated. Options give their owner the right—but not the obligation—to either buy or sell an asset at a predetermined price. Moreover, swaps involve an exchange of cash flows between two counterparties, in which (typically) at least one party accepts a series of cash flows determined by a random variable—often interest rates, exchange rates, or commodity prices. In an interest rate swap, for example, cash flows are "based on a 'notional principal' that is used to calculate the cash flow but is not exchanged."[42] At a predetermined date, the fixed-rate payer pays a coupon determined by the fixed interest rate stipulated in the contract—usually a premium over the appropriate Treasury rate. At the same time, the floating-rate payer owes a payment based on the relevant floating rate—usually some spread[43] on the applicable LIBOR[44] rate. Thus, swaps contracts allow firms to hedge against interest rate risk insofar as one firm absorbs market risk and its counterparty pays a premium for an assured fixed rate.

The risk transferring capacity of these instruments allows for protection

[42] Gary Gorton and Richard Rosen (1995): "Banks and Derivatives", an NBER Working Paper no. 5100. Cambridge, MA: National Bureau of Economic Research.
[43] *Spread:* A spread is a rate difference. For example, a spread on the LIBOR rate (see 5) could be the addition of 25 basis points to whatever the rate might be (i.e. 1 year LIBOR plus 25 basis points: 0.79 + 0.025).
[44] *LIBOR rate:* the London Inter-bank Offered Rate. This is the reference rate at which banks can borrow unsecured funds from other banks in the London wholesale money market.

from adverse price movements for both firms and investors. Parties in derivatives contracts have the opportunity to "disaggregate risk, bear those risks they can manage, and transfer those they are unwilling to bear."[45] Moreover, the ability of financiers to tailor derivative products to specified needs allows participants "to hedge risk in a manner more closely resembling the actual risk that they are assuming than was ever possible with ordinary securities."[46] Thus, innovation in the derivatives sector has accompanied exponential growth in its market size. According to the Bank for International Settlements, the over-the-counter derivatives market reached a notional value of $670 trillion in 2008 (it has since contracted to $582 trillion).[47] In 1992, the notional value of the OTC derivatives market was merely [sic] $10 trillion.[48] According to William C. Hunter and David Marshall, "this dramatic growth has raised concerns about the complexity of these instruments and the ability of managers, regulators, and market participants to understand the risks associated with their use."[49] Thus, it is important to explore the risks associated with "rapid and frequent transformations"[50] of firms' off-balance sheet assets and liabilities.

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[45] J. Carter Beese Jr. (1993): "Derivatives: Fundamentally Changing Corporate Finance, Asset Management... and the Retail Industry?" Remarks at 1993 Annual Meeting/Southern District Securities Industry Association.
[46] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss?
[47] Bank for International Settlements (2010): "Table 19: Amounts Outstanding of OTC Derivatives," in *BIS Quarterly Report*, December 2010.
[48] Notional values do not indicate the riskiness of derivative positions; they are only applicable in regard to market structure.
[49] George Kaufman and Robert R. Bliss (2006): "Derivatives and Systemic Risk: Netting, Collateral, and Closeout" in Journal of Financial Stability 2 (2006).
[50] William C. Hunter and David Marshall (1999): "Thoughts on Financial Derivatives, Systematic Risk and Central Banking: A Review of Recent Developments," a Federal Reserve Bank of Chicago Working

Part 1—Derivatives and Risk

Derivatives allocate specialized risks to those willing to pay the lowest premium for associated exposure. Though said risk has been "broken up and parceled out,"[51] bearing parties remain exposed to a variety of risks both characteristic of less complex securities and unique to derivatives. Scholars typically associate derivatives with market, liquidity, credit, and systemic risks. Some scholars contend that derivatives have different relationships to these risks than basic debt and equity instruments and thus require special attention from risk managers and regulators. Some of their arguments stem from the reality that OTC trading is far less transparent than established exchange trading mechanisms. As a result, some argue that regulators and managers cannot develop a clear understanding of the derivative market structure, the extremely rapid transformations that occur within it, or the concentration of positions within and beyond the industry. Because the shadow-banking segment expanded along with derivatives innovation, the relative opaqueness of derivatives trading and market positions has grown exponentially. Thus, it is necessary to evaluate the relationship between derivatives and financial instability.

For firms that trade derivatives, market risks can be extraordinary and lead to substantial losses. Though derivatives are often used to hedge risk, they are very susceptible to adverse market movements that have little or no downside

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[51] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).

protection. Moreover, when firms employ derivatives to speculate (trade for their own books), they can suffer staggering losses. George Soros, the renowned investment manager, lost around $600 billion for his Quantum fund on European bond and currency options in 1994.[52] Brian Hunter, a trader at hedge fund Amaranth Advisors, lost $6.5 billion betting on energy futures spreads in 2006. Jérôme Kerviel, an equity arbitrage trader at French bank Société Générale, lost €4.9 billion on directional stock index futures in 2008. Losses in derivatives markets are not limited to financial services firms. In 1994, Toyota incurred almost a billion dollar loss over six months attempting to hedge its foreign exchange risk.[53] In 1996, Japan's Sumitomo Corporation lost $3.46 billion in the copper futures market. Misguided derivatives trades have plagued seasoned financial houses' proprietary traders as well as industrial and manufacturing firms merely attempting to hedge risks.

An infamous example of the effect of derivative market risk occurred when Metalgesellschaft AG, a German engineering and commodities conglomerate, lost around $1.4 billion in an ill-advised effort to hedge with oil futures. Despite reputedly being a "sophisticated trading outfit," Metallgesellschaft's losses triggered an enormous ($1.9 billion) bailout from creditors and resulted in the termination of about 5,000 jobs.[54] The market implications were also

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[52] Brett D. Fromson (1994): "Speculator Sees Possible Danger in Derivatives," in *Washington Post,* April 14, 1994.
[53] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).
[54] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).

excruciating: "low oil prices were further depressed as the company attempted to liquidate its [massive] futures positions."[55] As a result of artificially depressed prices, oil refiners in the US eschewed hundreds of millions of dollars in revenue that they would have otherwise realized had Metallgesellschaft "stayed out of the hedging business."[56] Moreover, the issue divided financial scholars; some (Mello and Parsons) argued that the firm's energy market trading "was largely speculative"[57] and its position was "grossly oversized."[58] while others "claim that the firm employed a prudent and potentially very lucrative strategy of hedging long term energy delivery obligations with short-term futures and swaps."[59] These flawed trades illustrate the staggering market exposure that occurs at the behest of derivatives instruments and trading strategies.

Derivatives strategies are also subject to liquidity risk. According to Waldman, "depth, breadth, and resiliency" characterize a liquid market.[60] In derivatives markets, broker dealers are the chief liquidity providers; they sell, market, and create products. As the Metallgesellschaft AG case illustrates, huge notional contracts can be difficult to liquefy, especially as a firm faces huge losses,

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[55] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).
[56] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).
[57] Franklin R. Edwards and Michael S. Canter (1995): "The collapse of Metallgesellschaft: Unhedgeable risks, poor hedging strategy, or just bad luck?" in *The Journal of Futures Markets*, Vol. 15, Issue 3 (1995).
[58] Mark Wahrenburg (1995): "Hedging Oil Price Risk: Lessons from Metallgesellschaft" in *The Journal of Futures Markets*, Vol. 3, Issue 15.
[59] Stephen Craig Pirrong (1997): "Metallgesellschaft: A prudent hedger ruined, or a wildcatter on NYMEX?" in *The Journal of Futures Markets*, Vol. 17, Issue 5 (1997).
[60] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).

and can exacerbate an unfavorable market movement. While product liquidity is certainly a perceived concern, counterparty liquidity is of far greater interest. Though it may be impossible to perfectly perceive the liquidity of a market participant, the perception of illiquidity can erode a party's willingness to interact with the illiquid participant. Perceptions of illiquidity can lead to increased and unfavorable contract premiums as well as fears of counterparty risk, both of which can provoke increasing abstention (and decreasing liquidity).

Liquidity risk also has interesting implications for delta—otherwise known as dynamic—hedging, a common risk management practice. Instead of buying an option in exact opposition to a held position, delta[61] hedging involves actively maintaining a dynamic hedge position by constantly realigning its notional position in proportion to a desired level of risk exposure. This practice "allows for profits despite the existence of the hedge"[62] and is thus applied by many firms (despite often-burdensome transaction costs). The theoretical basis for delta hedging presupposes an entirely liquid market within which necessary adjustments to a delta position can be made. During periods of market instability (most notably idiosyncratic systemic events), market liquidity can evaporate almost instantaneously and result in an environment in which delta hedging is no longer possible. Such an environment would negate the intended purpose of the hedge, which is to shield an entity's market exposure from high volatility cycles.

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[61] The term *delta* refers to changes in instrument value with respect to changes in an underlying asset's price. Those who employ delta hedging seek to maintain a constant delta measurement.
[62] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).

Credit risk, which is similar to liquidity risk, is the "risk that a participant will default on contractual obligations to a counterparty, resulting in loss."[63] For exchange-traded products, a central clearing house (usually the exchange itself) guarantees all trades. For OTC derivatives, which are traded between two (or three) counterparties, credit risk is not mitigated by a functional clearinghouse and must be considered when a trade occurs. Measuring credit risk is a terribly complex process, which involves calculating the risk of replacing a counterparty's contractual obligation should said party default. To assign value to a defaulted contract, "one must calculate the value of all expected future cash flows that were erased by the default."[64] For risk managers, the evaluation of derivative credit risk requires estimates of a contract's current exposure as well as forecasts of potential exposure. Though current exposure is relatively simple to calculate, future exposure varies wildly and is extraordinarily difficult to measure. Volatility models and measurements require unrealistic assumptions, personal opinions, and a litany of interrelated variables. Thus, replacement cost valuation can be incredibly fastidious and can dramatically affect gravely important credit risk models.

Though credit risk has traditionally demanded concern from bankers and underwriters, it is even more significant for those who participate in derivatives markets. Because some derivatives contracts span several years, involved parties

[63] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).
[64] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).

must carefully scrutinize the current and future creditworthiness of their collaborator over a longer period of time than other, more traditional banking functions. By allowing for long-maturity derivative contracts, credit models also must account for a more diverse range of potential economic and financial scenarios and inherently more market volatility. Some scholars assert that some financial services firms, who traditionally pinpoint short-term risks, "may look for short-term profits attached to unwanted long-term repercussions."[65] Derivatives, especially those traded over-the-counter, exhibit credit risk properties rarely seen in other financial instruments.

Part 2—Derivatives, Shadow Banking, and Systemic Risk

Due to the primacy of credit risk in OTC derivatives markets, institutional creditworthiness (and perceptions of it) often influence market participation. For this reason, "the credit rating of an OTC derivatives dealer is more closely scrutinized than that of a stocks and bonds trader because the OTC derivatives dealer is an actual party to the contract."[66] The heightened value of credit scores for derivatives dealers has compelled executives to spin off subsidiary derivative-specialized institutions shielded from their parents' less appealing balance sheets. The development of these institutions (known as Derivatives Products Companies) was a fundamental precursor to the rise of the shadow banking

[65] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).
[66] Adam R. Waldman (1994): OTC Derivatives and Systemic Risk: Innovative Finance or the Dance into the Abyss? in (43) American University Law Review 1023 (1994).

system. Thus, shadow banking and derivatives instruments are inexorably linked—the unique demands of the OTC derivative sector provided the rationale for the inception of a non-regulated system of specialized financial institutions, which expanded rapidly thereafter.

The unsecured and undisclosed nature of these off-balance sheet endeavors has significant implications for systemic risk theory. In the case of an extremely adverse market movement, there is a risk that a significant player could default on its contractual obligations to make payments, which would result in a cascade of defaults throughout the system. The relative concentration of derivatives dealers among several banks (and their subsidiaries) would only exacerbate such contagion. Moreover, the long-term maturity of instruments and the interconnected nature of swap obligations can tie firms' fates together in incomprehensible ways and increasing the likelihood of such a collapse. The threat of substantial derivatives losses disrupting market functionality and causing a payment default meltdown is considerable.

Many financial services firms employ derivatives for speculative, proprietary trades that are often unhedged. While often bolstering a firm's bottom line, a heavy reliance on proprietary trading can lead to devastating collapse. In addition, derivatives hedging strategies often rely on misguided theories of liquidity. In adverse market conditions, when hedges are most valuable, absolute liquidity required to execute a position may not be available. It is easy to conceive of a systemic scenario in which the default of a few firms

precludes other firms (who may be completely liquid and solvent) from executing hedges to protect from the market's reaction to said defaults. Moreover, as a result of delta hedging strategies, other seemingly healthy firms could further depress asset prices by rebalancing their hedge portfolios in response to a collapsing market. The intensifying implications of derivative instruments on financial crises are stark.

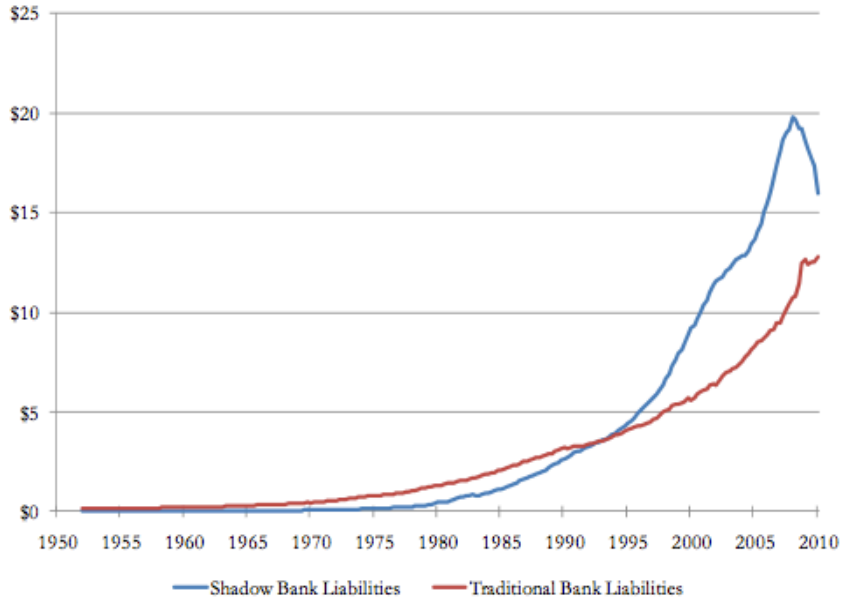
1.4

SHADOW BANKING

In the early twentieth century, the United States government established both the Federal Reserve System (1913) and the Federal Deposit Insurance Corporation (1933) to reduce the likelihood of bank runs. Thus, the government established public sector oversight for the traditional banking sector, which is comprised of depository institutions like commercial banks, savings and loans, credit unions, and industrial loan companies, through deposit insurance and liquidity provisions. According to New York Fed economists Zoltan Pozsar and Tobias Adrian, regulatory programs like the FDIC safeguard large traditional banks from the "risks inherent in reliance on short term funding by granting them access to liquidity and credit put options in the form of liquidity backstops from the discount window and deposit insurance."[67] Another sector of finance has risen to rival the value and viability of the traditional banking sector in the past 25 years. Non-depository institutions such as investment banks (and their holding companies), hedge funds, and money market funds have evolved into a *shadow banking system* that intermediates credit, provides liquidity, and operates with limited regulation.

[67] Zoltan Pozsar, Tobias Adrian et. al., "Shadow Banking," (Federal Reserve Bank of New York Staff Reports: No. 458, July 2010), pgs. 2-9.

The emergence of a parallel, esoteric banking system is a consequence of two critical developments in the financial sector. First, the widespread growth of derivative securities over the past quarter century has exponentially increased the demand for collateral on margin. Second (and not unrelated to the first development), financiers have begun to securitize-and-distribute a tremendous amount of loans into the capital markets.[68] By securitizing debt, banks were able to issue bonds that would serve as collateral for repurchase agreements, "freeing other categories of assets for use as collateral in derivatives transactions and for use in settlement systems."[69] This phenomenon began in the late 1990s and allowed firms to vastly increase their leverage.



Source: Flow of Funds Accounts of the United States as of 2010:Q1 (FRB) and FRBNY.

Figure 1: Shadow Bank Liabilities vs. Traditional Bank Liabilities

[68] Gary Gorton (2009): "Slapped in the Face By the Invisible Hand," *Federal Reserve Bank of* Atlanta Jekyll Island Conference Proceedings.
[69] Gorton (2009): "Slapped in the Face By the Invisible Hand."

The arrival of shadow banking infrastructure, though unbeknownst to everyday investors, allowed for the development of a vastly complex credit intermediation and enhancement process. Analysts attribute the term itself to Paul McCulley, a portfolio manager at PIMCO, who advocates Keynesian economics.[70] This mechanism "provides savers with information and risk economies of scale in screening and monitoring borrowers and by facilitating investments in a more diverse loan portfolio."[71] Credit intermediation involves credit transformation, which is the enhancement of the credit quality of debt; maturity transformation, which refers to the use of short-term deposits to fund long-term loans—creating liquidity for the saver; and liquidity transformation, which is the use of liquid instruments to fund illiquid assets.[72] This process can occur at the behest of the government directly—on depository institutions' balance sheets—or indirectly through conduit entities, affiliated hedge funds, money market funds, and securities lending practices.

In the shadow banking system, the credit intermediation process occurs at the same time through "a daisy-chain of non-bank financial intermediaries"—a process that includes loan origination, loan warehousing, ABS[73] issuance, ABS warehousing, ABS CDO[74] issuance, ABS intermediation, and wholesale funding.

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[70] Paul McCulley, "Teton Reflections," in *PIMCO Global Central Bank Focus*, 2007.
[71] Poszar, Adrian, et al. "Shadow Banking," pg. 7.
[72] Poszar, Adrian, et al. "Shadow Banking," pg. 8—"What Is Shadow Credit Intermediation?"
[73] *Asset-backed security*: an ABS' value and payments are derived from and collateralized by an instrument (or instruments) such as a loan, lease, or other receivable.
[74] *Collateralized debt obligation*: CDOs are structured ABS products whose value and payments are derived from a portfolio of debt instruments. originators will split a CDO into tranches determined by riskiness.

Different types of shadow institutions perform each of these distinct operational techniques (see figure 2 below).

	Function	Shadow Banks	Shadow Banks' Funding*
Step (1)	Loan Origination	Finance companies	CP, MTNs, bonds
Step (2)	Loan Warehousing	Single and multi-seller conduits	ABCP
Step (3)	ABS Issuance	SPVs, structured by broker-dealers	ABS
Step (4)	ABS Warehousing	Hybrid, TRS/repo conduits, broker-dealers' trading books	ABCP, repo
Step (5)	ABS CDO Issuance	SPVs, structured by broker-dealers	ABS CDOs, CDO-squareds
Step (6)	ABS Intermediation	LPFCs, SIVs, securities arbitrage conduits, credit hedge funds	ABCP, MTN, repo
Step (7)	Wholesale Funding	2(a)-7 MMMFs, enhanced cash funds, securities lenders, etc.	$1 NAV shares (shadow bank "deposits")

*Funding types highlighted in red denote securitized funding techniques. Securitized funding techniques are *not* synonymous with secured funding.

Source: Shadow Banking (Pozsar, Adrian, Ashcraft, Boesky (2010))

Figure 2: Shadow Credit Intermediation[75]

This mechanism melds non-depository institutions into a credit intermediation network, which "forms the backbone of the shadow banking system."[76] The intermediation process transforms the credit quality of loans: what begins as a long-term, somewhat-hazardous loan becomes a marketable repackaged security that offers liquidity and transparency. According to Pozsar and Adrian, the shadow banking system is "a system which reallocates the three functions of banks[77] across a variety of specialist, non-bank financial intermediaries with distinct competitive advantages."[78]

The shadow banking system contains three particular organizational classes: the government-sponsored sub-system, the internal sub-system, and the

[75] *CP:* commercial Paper; *MTN:* medium term note; *ABCP*: asset-backed commercial paper; *LPFC*: limited purpose finance company; and *SIV:* structured investment vehicle.
[76] Poszar, Adrian, et al. "Shadow Banking," pg. 13.
[77] Credit, maturity, and liquidity transformation.
[78] Poszar, Adrian, et al. "Shadow Banking," pg. 19.

external sub-system. These entities secure funding through the wholesale funding market—a series of issuances, mainly involving money market instruments, medium-term notes, and public bonds. This funding system is indelibly susceptible to market idiosyncrasies and credit freezes, both of which threaten the stability of the shadow banking system.

The Federal Home Loan Banks, Fannie Mae, Freddie Mac, and Ginnie Mae comprise the government-sponsored segment of the shadow banking system. The development of these organizations has both fundamentally altered the banking industry and allowed for the development of shadow banking. Instead of originating loans and holding them to term, these government-sponsored enterprises instituted a "securitization-based, originate-to-distribute credit intermediation process."[79] GSEs provide term loan warehousing to banks, while Fannie Mae and Freddie Mac provide credit insurance and securitize and distribute loans. According to Pozsar and Adrian, these techniques garnered interest from both banks and non-banks and became widely adopted in their credit intermediation and funding practices. Moreover, these institutions are held off of the government's balance sheet (Fannie Mae had been privatized prior to re-nationalization in 2008 in the wake of the housing crisis), but still hold an implicit government guarantee—much like an SPV.[80] It is necessary to mention that the government-sponsored sector of the shadow banking system does not

[79] Poszar, Adrian, et al. "Shadow Banking," pg. 21.
[80] *SPV:* a *special purpose vehicle* is a subsidiary company or entity that is created to remove liability from a parent company.

originate loans; it focuses on loan processing and funding.[81] Despite implicit government support, these entities provided the foundation of and methodological basis for the shadow banking system.

Over the past thirty years, the traditional banking sector has radically refashioned its constitution. The largest banks have traditionally relied on depository funds and loan origination for revenue and managed exposure to credit risk. These firms have since begun to emphasize loan securitization, the wholesale funding process, and fee-based initiatives, while their risk management has shifted its exposure to market risk. Under the auspices of "bank holding companies," traditional banks aggregated asset management, broker-dealer, and other specialist functions under one banner. This allowed banks "to transform their traditional process of hold-to-maturity, spread banking to a more profitable process of originate-to-distribute, fee-banking."[82] Management transferred a vast majority of the credit intermediation process into newly held, semi-unregulated specialized subsidiaries—giving rise to the shadow banking industry. By shifting the role of loans—from originate-to-hold to originate-to-securitize, bankers fundamentally altered the nature of credit risk.

Fundamentally, banks no longer lent on the basis of creditworthiness, but on the ability of their salespeople to make a market for securitized loans and distribute them accordingly. This became the basis for a "securitization-based

[81] Poszar, Adrian, et al. "Shadow Banking," pg. 22.
[82] Poszar, Adrian, et al. "Shadow Banking," pg. 24.

shadow credit intermediation program,"[83] which allowed for the pursuit of unhealthy lending practices through subsidiaries with lenient capital requirements, oversight, and regulation. Thus, lending and credit intermediation processes spanning the globe now relied on networks of bank holding companies, their specialized subsidiaries, wholesale funding, and international capital markets.

The external shadow banking system is very similar to the internal system, but is dominated by non-aggregated specialized finance houses. These independent actors adopted the practical combination of bank and market-based credit intermediation employed by bank holding companies (BHCs) and grew into an interconnected network of intermediaries that operated beyond the regulatory and insurance purview of the banking sector. The credit intermediation processes of broker-dealers and non-bank specialist intermediaries, along with backstops provided by risk repositories, comprise the external shadow banking system.[84] Broker-dealers, such as Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch, and Morgan Stanley, exploited lax leverage limits to conduct activities similar to those within the internal system, but at higher multiples and with riskier products like subprime mortgages and leveraged loans. These broker-dealers utilized repo funding, internal hedge funds, and proprietary trading desks to fund their loan pools and credit assets. A juxtaposition of the external and internal shadow banking

[83] Poszar, Adrian, et al. "Shadow Banking," pg. 25.
[84] Poszar, Adrian, et al. "Shadow Banking," pg. 34.

systems reveals that only one set of broker dealer subsidiaries "were backstopped by the Federal Reserve and FDIC," while "the numerous other subsidiaries that were involved in the origination, processing, and movement of loans and structured credits" were not.[85] Moreover, the non-bank specialist (hedge funds, money market mutual funds, independent structured investment vehicles) credit intermediation process involved riskier non-conforming loans, an originate-to-fund process, and dependency on access to broker-dealer and BHC capital markets desks and lender-of-last-resort functions. The internal and external shadow banking credit extension processes were inextricably connected and incredibly convoluted. The external process, however, existed behind closed doors and away from the purview of regulatory oversight.

Just as independent specialists relied on BHCs and broker-dealers for market intermediacy, BHCs and broker-dealers depended heavily on credit risk repositories to provide risk and insurance capital for the securitization process. These entities, such as mortgage insurers, subsidiaries of large insurance companies, credit hedge funds, and credit derivative specialists, "absorbed the tail risk out of loan pools processed through the shadow banking system,"[86] making these loans and asset backed securities perceivably credit-risk free. In the lead up to the 2007 crisis, a self-reinforcing cycle emerged wherein the liabilities of shadow banking institutions themselves were deemed high quality due to the perceived quality of their underlying collateral—the AAA-rated

[85] Poszar, Adrian, et al. "Shadow Banking," pg. 36.
[86] Poszar, Adrian, et al. "Shadow Banking," pg. 42.

tranches of ABCPs and ABSs. These entities typically utilized short-term credit conduits in money markets to secure their long term funding. When credit markets turned arid in 2008, shadow institutions were unable to roll over their short-term securitizations and finance their long-term assets and obligations, which triggered a contagious run on the shadow banking system.

In the wake of the 2008 crisis, government interference had a paradoxical and indeterminate effect on the shadow system. While many shadow institutions (typically those with exorbitant leverage) failed when they were unable to secure funding, those with "reasonable leverage and a diverse set of funding options"[87] persevered. However, ambiguous intercession on the part of the Treasury Department and broker-dealers allowed for the survival of inferior institutions and the failure of some well-run, seemingly sound shadow banks. Though these failures require attention on a case-by-case basis, disproportional access to last resort funding (and thus relationships with bulge-bracket parent firms) seems to be a common theme. The fickle nature of this infrastructure reveals a defect in the mammoth shadow banking system. Because wholesale funding (characterized by institutional cash balances) is extremely unstable and institutional investors are hypersensitive, the asymmetries of shadow funding engender ominous fault lines that spread across all three sub-systems of the shadow industry. In the past, this precariousness has resulted in contagious runs on the shadow banking system—some of which have spawned systemic instability.

[87] Poszar, Adrian, et al. "Shadow Banking," pg. 58.

1.5

SECURITIZATION AND SUBPRIME

In 2000, Congress passed the Commodity Futures Modernization Act, which effectively eliminated OTC derivatives from regulatory purview. The number of traded contracts exploded in the year period during which Congress enacted the legislation and have grown rapidly since. Moreover, the legislation, which Congress enacted in the last days of the Clinton Administration, opened the door for an innovation boom in both financial instrument engineering and institutional development. The practice of securitization, which entails pooling and repackaging contractual debt, expanded rapidly at Wall Street institutions, insurance securities firms, and lenders. Wall Street firms enjoyed two unique benefits from the securitization process. First, securitization allowed management to dump pools and tranches of ungainly loans into special purpose vehicles or other shadow banking entities, thereby removing these assets from their balance sheets. This development effectively reduced firms' capital requirements and released cash reserves. Moreover, the securitization process allowed firms to pool fixed income assets with different risk characteristics, thereby reducing idiosyncratic risk and diversifying loan pools. The rise of securitization was a boon for Wall Street; it allowed for the growth of a nearly trillion-dollar market and record profits across the industry.

Lenders began to sell mortgages to investment banks and other shadow institutions who then pooled and tranched thousands of mortgages, car loans, and other fixed income assets into collateralized debt obligations. This process is diagrammed in Figure 3:

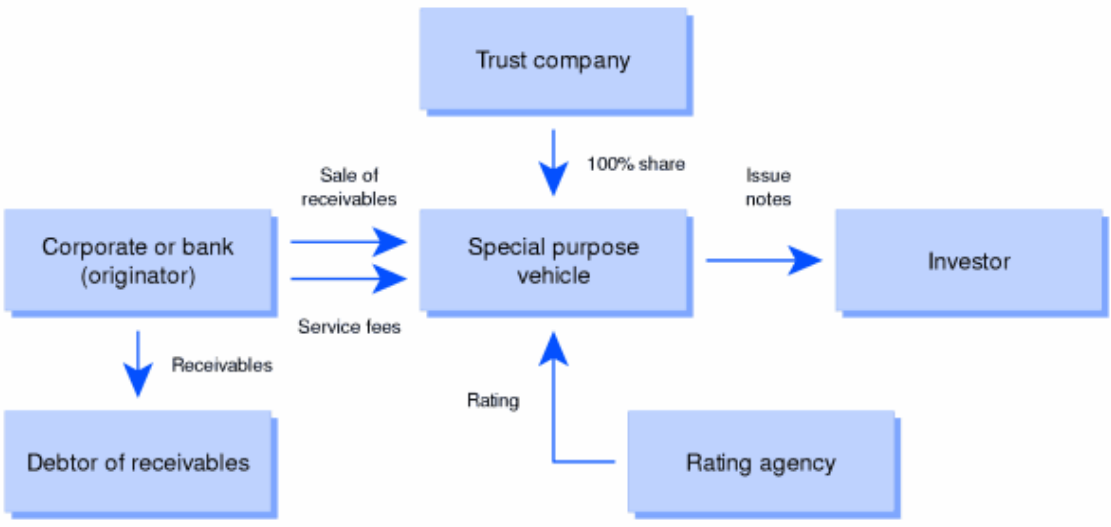

Figure 3: Securitization Chain
(Source: Internationaltaxreview.com)

Moreover, further financial innovation allowed banks to create specialized CDOs and tranches of CDOs for different investors' specific needs. As structured, asset-backed securities, CDOs are split into tranches—different risk classes—whereby interest and principle payments are made on a seniority basis and premiums rates compensate for increased risk. On average, bankers would divide CDOs into seven or eight tranches, with 2 or 3 "senior" level AAA rated tranches and several riskier tranches (rated A, BBB, and below). In this way, CDOs allowed institutional investors, who could only have exposure to investment-grade

products, to "gain exposure to assets that, on their own, had been too risky."[88] The riskier tranches appealed to investors with higher risk-return appetites. The CDO market grew exponentially from 2001 to 2007—issuance grew globally from around $78 billion in 2001 to more than $420 billion in 2007.[89]

From 2000 to 2007, as interest rates steadily decreased, more and more people implicitly gained access to mortgage lending. The nature of this expansion, unfortunately, would prove rotten. The most credit-worthy individuals (as determined by banks and lenders) were previously able to access prime mortgage loans. However, the extremely profitable ABS securitization machine compelled lenders (banks, thrifts, etc.) to lend money to subprime borrowers, or those with a riskier profile and higher probability of default, because they could sell the expected cash flows to an SPV for securitization. According to Robert Gnaizda, former policy director for the Greenlining Institute, "all of the incentives that the financial institutions offered to their mortgage brokers were based on selling the most profitable products."[90] The subprime market grew rapidly from 2002 to 2005, as lenders like Countrywide, Ameriquest, and New Century realized record profits.

The rise of securitization was a boon for credit rating agencies. The three most prominent CRAs, Moody's, Standard & Poor's, and Fitch, charged fees to assess the risk involved with CDO tranches, as they had done traditionally for

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[88] Anna Katherine Barnett-Hart (2009): *The Story of the CDO Market Meltdown: An Empirical Analysis*. Harvard College: Department of Economics—Honors Thesis.
[89] Securities Industry and Financial Markets Association (2010): "Global CDO Issuance."
[90] *Inside Job* (2010): directed by Christopher Ferguson. New York: Sony Pictures Classics.

corporate and sovereign debt instruments. In the mid 2000s, a flourishing base of CDO investors relied heavily on the ratings produced by these firms to assess the riskiness of CDO tranches. As the demand for CDOs spiked, "the rating agencies came under enormous pressure to quickly crank out CDO ratings, while the market exploded faster than the number or knowledge of analysts."[91] The CRAs developed risk assessment models to churn out CDO ratings. Many of these models were premised on the movements and characteristics of other bonds due to the lack of historical information regarding CDOs. Adjustments to these models were made "haphazardly"[92] based on the nature of the instrument. Investor overreliance on credit ratings, especially those predicated on the risks associated with corporate bonds, resulted in widespread optimism about the CDO boom. Investors and ratings analysts alike failed to account for portfolio risk, downturn correlation, and loss-given-default characteristics specific to CDOs—especially RMBSs[93].

As the demand for CDOs increased, financial engineers sought inventive new ways of satisfying the appetite of the industry's ravenous securitization machine. Using the same principles of innovation that drove the derivatives boom, these analysts cooked up significantly more complex instruments, including CDOs-squared[94] and synthetic CDOs[95]. Around the same time in 2004,

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[91] Anna Katherine Barnett-Hart (2009): The Story of the CDO Market Meltdown: An Empirical Analysis.
[92] Anna Katherine Barnett-Hart (2009): The Story of the CDO Market Meltdown: An Empirical Analysis.
[93] Residential Mortgage Backed Securities.
[94] A CDO-squared, as you might imagine, is essentially a "CDO of a CDO." It consists of repackaged

the Securities and Exchange Commission relaxed capital ratio requirements for the 5 major broker dealers (also the five largest shadow institutions), who responded by systematically increasing their debt financing.

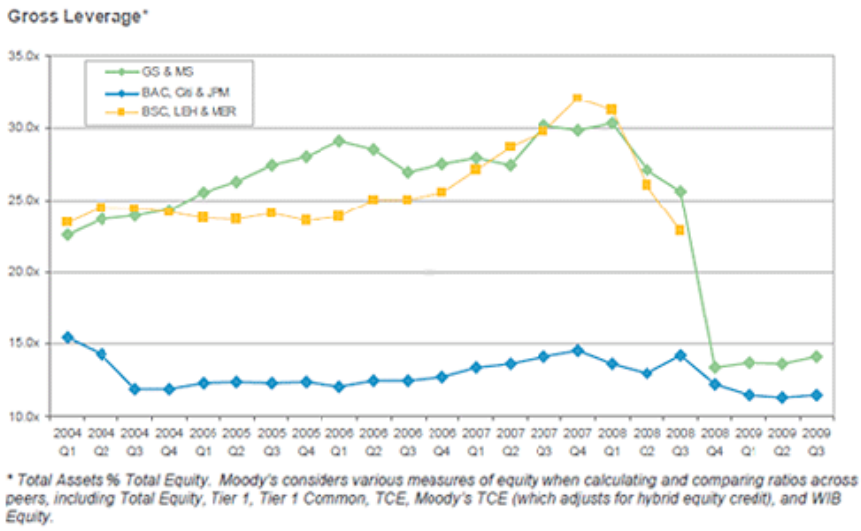

Figure 4: Leverage among significant financial institutions[96]
(Source: Economist Intelligence Unit)

With a more lenient capital requirement, the broker dealers borrowed up to 33 times their asset base. According to Daniel Alpert, a hedge fund manager, this degree of leverage "meant that a tiny 3% decrease in the value of their asset base could leave them insolvent."[97] While leverage certainly fueled the securitization chain and magnified profits, it also overexposed these institutions to an idiosyncratic systemic shock.

One can easily draw a parallel between the over-levered investment banks

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mezzanine CDO tranches that form a highly rated bond. The repackaged tranches were typically risky, though their pooling resulted in a much higher rating.

[95] A synthetic CDO is a pool of credit default swap contracts. It generates payments similar to that of an ABS CDO, but does not require asset ownership.

[96] Notice that institutions with commercial banking practices (JPMorgan, Citi, and Bank of America) and accompanying oversight maintained relatively low leverage ratios.

[97] Quoted in *Inside Job* (2010): directed by Christopher Ferguson. New York: Sony Pictures Classics.

in 2007 to the extreme leverage employed by Long Term Capital Management, a notable hedge fund, in the late 90s. By employing a cachet of academic and financial prodigies, LTCM was able to attract substantial institutional investments and demand favorable spreads from its broker and lenders. On Wall Street, traders at the major banks revered LTCM's pedigree and feared its potential. After initial fundraising (no doubt bolstered by an elite roster of traders) in 1994, Long Term began trading with around $1.25 billion under management.

By December 1995, LTCM boss John Meriwether had employed a bold investment strategy to grow the fund's assets under management to around $102 billion. It seemed that the highly lauded cast of traders and economists were invincible--or at least vastly superior to their hedge fund peers. Meriwether's strategy involved fixed income arbitrage, spread arbitrage, and pairs trading to collect thin spreads on otherwise profit-less margins. To make a profit, he exploited the firm's unique reputation to massively leverage its balance sheet and amplify thin spreads into astounding profits. For instance, in its best year, the firm managed $4.7 billion dollars of equity and borrowed an astonishing $128 billion on top of its assets. In 1997, Long Term's quantitative analysts ran out of bond arbitrage spreads to trade on and were forced to adopt a more aggressive trading strategy in order to maintain high returns, which resulted in a $460 million dollar loss over May and June.

Long Term's downfall came in the next year; when it began to turn away

investors in order to greedily keep more profits in house. In an ironic twist of fate, as a Russian bond crisis aggravated markets, Meriwether's equity reserves depleted as a result of collateral calls. When the rest of the industry caught wind of LTCM's positions, traders began to prey on its high leverage and Long Term's liquidity began to dry up. In order to pay its collateral obligations, Long Term had to sell many of its long-term positions at a tremendous loss, further exacerbating the pressure on its overstretched capital.

Due to the complexity and sheer volume of its derivative contracts (almost every bank in the world was an LTCM counterparty), the New York Fed feared that Long Term's collapse would rattle the foundations of the financial system--and possibly take a few banks down with it. When asked about the possible collapse of Long Term, the President of the New York Fed, William McDonough, admitted that "markets would … possibly cease to function."[98] McDonough orchestrated a bailout of LTCM for $3.625 billion that included nearly every bank on the Street. The original partners lost their entire $1.9 billion stake in LTCM, but the financial system escaped nearly unscathed due to the Fed's rescue plan and cooperation among Wall Street giants. Though the banks who invested capital were largely paid back in the ensuing years, the fund's partners felt the ill effects of speculative failure and many of their careers largely ended. Soon after, Merrill Lynch analysts released a report condemning reliance on mathematical models such as those utilized by LTCM's traders.

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[98]Roger Lowenstein (2001): *When Genius Failed: The Rise and Fall of Long-Term Capital Management,* New York: Random House.

The differences between LTCM's rise and fall and that of the investment banks are stark, but some of the basic characteristics remain. After developing an extremely profitable strategy, both the banks and LTCM took on massive loads of debt in order to dramatically increase exposures and thereby amplify profits—as long as things were *going well* so to speak. The LTCM case has increasingly significant parallels with the eventual bail out of Bear Stearns, which occurred in March, months prior to the widespread hysteria of September and October 2008. Spurred on by rumors of Fannie Mae and Freddie Mac's massive mortgage losses, investors pummeled financial stocks in late February and early March 2008. They hounded on rumors that Bear was floundering under the weight of a massive mortgage portfolio, much like traders preyed on the (true) estimation that LTCM's arbitrage strategies had moved against them. By trading against LTCM's positions, its competitors widened its convergence bets so much so that most of LTCM's capital was effectively tied up in margin calls. Market fickleness and the Wall Street rumor machine played a huge role in expediting the collapse of both LTCM and Bear Stearns.

The rhetoric surrounding Bear Stearns' collapse was eerily similar to that regarding Long Term Capital. By Wednesday March 12th, as its customers withdrew funds and its liquidity began to dry up, Bear began to send out feelers for an emergency loan. Fed officials, including Tim Geithner, held a conference call with Hank Paulson and his undersecretary Robert Steel in Washington. Geithner argued that Bear's failure would be "catastrophic for money market

funds, rile the derivatives markets," and could lead to a wider systemic collapse, which was "exactly what Paulson and Bernanke had been fearing."[99] All of the regulators feared that the spillover effects of a Bear Stearns default would threaten other Wall Street firms and "lead to a broader panic, as had occurred during the LTCM meltdown."[100] Moreover, much like LTCM had turned away investors shortly before collapsing, Bear defied J.C. Flowers and Company's[101] recommendation the previous summer to engage in a stock sale to raise capital.

Bear Stearns survived the failure of its internal hedge funds—the first casualties of the mortgage crash—in the summer of 2007, but would succumb to the collapse of Fannie Mae and Freddie Mac the following February. At the behest of Paulson and others at Treasury, Fannie and Freddie became the conduits with which the government would attempt to keep the mortgage securitization machine afloat. By forcing Fannie and Freddie to "raise capital by selling stock faster than they lost it in mortgages,"[102] regulators unwittingly drove financial stocks into the ground in late February of 2008. Bear was hit the hardest; its stock price began the year at $85.30 (with a 52 week high of $172), began the month of March at $70.10, and plunged to $63 by Monday March 10th. Merrill Lynch and Lehman Brothers' stocks lost about 15% of their value over the same period. Bear's extremely high leverage ($11.1 billion in equity capital supporting around $395 billion in assets) required about $10 billion of overnight

[99] Roger Lowenstein (2010): *The End of Wall Street*. New York: Penguin Press.
[100] Lowenstein (2010): *The End of Wall Street.*
[101] A prominent private equity investment firm.
[102] Lowenstein (2010): *The End of Wall Street.*

financing to operate, and rumors abounded about the firm's supposed cash shortage.[103]

Figure 5: Bear Stearns 52-week stock price
Source: Thomson Reuters

Despite harsh denials and media appearances by CEO Alan Schwartz, Bear was unable to quell the liquidity rumors and began to lose customers. As its cash reserves began to dry up, Bear's management implored JPMorgan chief Jamie Dimon for a $30 billion dollar emergency loan.[104] He promised to help, but noted that the government would also have to step in. On Friday March 14th, the New York Fed reached a deal with JPMorgan and Bear Stearns: the Fed would make a loan to JPMorgan, who would then extend a secured line of credit to Bear. Though seemingly stable, this new source of financing did little to quell investor confidence and Bear's stock plunged to $30 at market close Friday afternoon.

Fed officials feared that the failure of Bear Stearns would trigger a

[103] Lowenstein (2010): *The End of Wall Street.*
[104] Lowenstein (2010): *The End of Wall Street.*

meltdown across the entire financial services industry—and intervened to prevent Bear's bankruptcy. Paulson eventually brokered a deal wherein JPMorgan would acquire Bear Stearns for $2 per share. Jamie Dimon, the CEO of JPMorgan, agreed to assume Bear's trades (so Bear could continue operating in the interim) provided that the government would "finance $29 billion of Bear's most problematic [mortgage] assets."[105] News broke about the JPMorgan's purchase at 6 o'clock p.m. on Sunday, March 16th. Though JPMorgan would later tack $8 onto its purchase price, the sale of Bear Stearns for $2 per share—as orchestrated by the government—was a striking departure from its 52-week high of $160 per share (even the adjusted $10 per share—or $1.2 billion—was grossly discounted). The consummated deal (at $2 per share) indicated a 93% discount on Bear's market capitalization as of the previous *Friday*. In fact, the original $236.2 million dollar purchase price was a steep discount on Bear's NYC headquarters building *alone*, which had itself been valued at $1.1 billion—and cost $700 million to build. Though the rescue drew ire from many pundits, they recognized that it was "aimed at averting a Bear Stearns bankruptcy and a spreading crisis of confidence in the global financial system."[106] Critics contended that "the Bear rescue seemed to promise a helping hand to the next financial firm, now matter how reckless, that came running for help."[107]

Section 2.1 will build a foundational game theory model of contagious

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[105] Lowenstein (2010): *The End of Wall Street.*
[106] Associated Press (2008): "JPMorgan to buy Bear Stearns for $2 a share" in *US Business* on MSNBC.com. http://www.msnbc.msn.com/id/23662433/ns/business-us_business/ Accessed 28 Feb 2011.
[107] Lowenstein (2010): *The End of Wall Street.*

financial crises. Though simplified, it will reveal the fragility of the largest shadow banking institutions and their sources of financing. Moreover, the model in Section 2.1 will illustrate and evaluate the role of government in systemic crises. In particular, it will explore different policy responses and interventions in light of their ability to mitigate the risk of systemic collapse. Section 2.2 will continue this delineation of the subprime crisis through the prism of Section 2.1's fragility model. Section 2.2 will analyze the series of events that began with Bear Stearns' collapse and culminated in the widespread bailout of the financial services industry with taxpayer funds.

2.1

MODELING INSTABILITY

This model of systemic contagion will rely significantly on the work of Roger Lagunoff and Stacey Schreft (1998). It will also build heavily on the work of Diamond and Rajan (2009), Adrian and Brunnermeier (2010), and Huang, Zhou, and Zhu (2009). This game theory stochastic model of financial contagion revolves around a set of financial institutions (I will include major pre-crisis "banking" institutions—bank holding companies and investment banks). Financial institutions own assets that generate a return (mortgage backed securities, CDOs, or some mix thereof—which for the sake of this model will be considered one asset class) and require period-to-period financing, details of which will remain unspecified (e.g. overnight paper, term loan, or repo agreement). This model will also include a set of investors that provide financing options for the financial institutions. For the sake of the model, these investment entities can choose between lending to a financial institution (a risky investment) and investing in a safe asset.

At time T an investor's portfolio allocation will be $(a_{x,t}, a_{y,t}, a_{s,t})$, where x and y refer to specific financial institutions and s refers to the safe asset. Each investor must allocate its portfolio in one of four ways. An investor can have an undiversified portfolio of risky investments in one financial institution: (2,0,0) or

(0, 2, 0). An investor may also be completely invested in the safe asset, with a portfolio allocated (0, 0, 2). Further, an investor could have a fully diversified portfolio with risky investments in two different financial institutions: (1, 1, 0). Finally, an investor can have a risky-safe mixed portfolio constructed in one of the following ways: (1, 0, 1) or (0, 1, 1). An investor's return will be: $r\,(a_{x,T}, a_{y,T}, a_{s,T})$. If an institution does not fail during the period, it pays a return to the investor at the end of that period. Investments in financial institutions are made at T_n and realized at T_{n+1}.

Investors (sources of financing) will become insolvent if hit with an iid[108] shock at any point $T \geq 0$. Shocks can either hit an investor(s) or an institution(s). Let us assume initially that institutions hit with shocks will default on their payment obligations to investors and investors hit with shocks will not provide financing to institutions. It is also important to note that each institution must have two separate sources of intraperiod financing in order to remain operable. Assuming that the critical level of funding is $\overline{R}$ for each institution, the expected return to investors can be described as:

$$\{0 \text{ with probability } q;\ \frac{2\overline{R}}{N} \text{ with probability } 1\text{-}q \text{ at } T = 1$$

$$\{\frac{2\overline{R}}{N} \text{ if at } T > 1, N \geq 2$$

$$\{0 \text{ if at } T > 1, N < 2$$

Where q is the probability that an institution is hit by a shock and N is the

[108] Independently and identically distributed, random.

number of investors. (This is subject to alteration when post-shock asset sales are introduced).

Let us assume that at $T = 0$, an investor with \$2 prefers a maximum return diversified portfolio (1, 1, 0) with both loans made to suitably funded institutions. To clarify, each investor loans \$1 to each of two institutions and each institution receives \$1 from each of two investors. This results in a web-like chain structure of institutions and their financiers. A closed chain (one unaffected by shocks) is a set of institutions and investors such that each institution (A-D) is fully funded, each investor (1-4) diversified, and each participant linked in some way. A closed chain will look something like this:

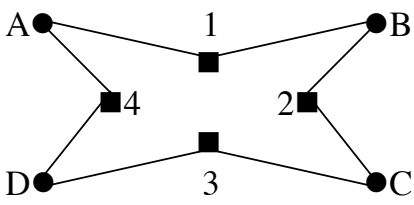


Figure 6: A Closed Chain[109]

Moreover, when a shock hits one of the investors (keep in mind that the term "investor" abstractly refers to any source of financing for a financial institution and is not in fact an actual "investor) in a chain, it begins to unravel and results in an open chain. Shocks will only occur at $T \geq 0$:

[109] Roger D. Lagunoff and Stacy L. Schreft. 1997: *A Model of Financial Fragility*. Presented at the Game Theory and Information series (EconWPA).

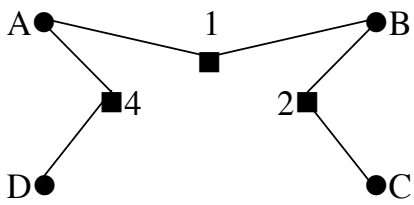


Figure 7: An Open Chain[2]

When a liquidity shock hits, institutions need to meet demands for cash from other counterparties (for commercial banks, this would most likely be depositors; for investment banks, it could be margin calls on derivative contracts or any other payment obligation). After a shock occurs, an institution can sell off a fraction of its assets (dZ, where Z represents the firm's total assets and d is the proportion of total assets to be sold) at $t+1$ for price P_o per unit of at-maturity face value to an entity not explicitly or immediately affected by the liquidity shock (a hedge fund, bank with longer term liabilities, or private equity firm, etc.) This is a suboptimal decision; however, because the asset sale in expectation of a liquidity shortage will occur at a depressed price. If holding the assets to maturity allows the institution to realize a return of 1, selling them at $T = o$ for price P_o gives a return $P_o < 1$. [For prospective buyers with longer term (or "unlimited") liability, purchasing the depressed assets is a risky investment, but one their appetite for risk is willing to consider—it is profitable to purchase an asset at depressed price $P_o < 1$, hold it to maturity, and realize a return of 1.] By meeting its liquidity demand; however, the bank is able to attract necessary short-term funding to remain operable during the period, until the next reallocation of funds occurs, as illustrated below:

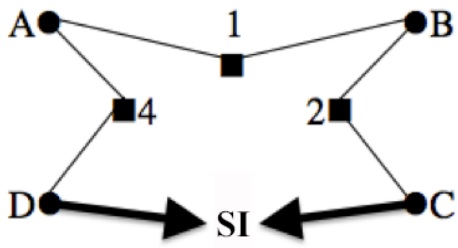


Figure 8: Re-closed chain after asset sale

Let us also assume for the sake of the model that institutions may only engage in an asset sale at *one* point during the time period of the model. That is, it is impossible for an institution to sell off a major portion of its assets at depressed prices more than once, as a function of the high leverage ratios common among such institutions. In figure 3, after a shock knocked out investor 3, institutions C and D faced a lack of funding. They sold off a fraction *d* of their assets *Z* to investor 5 in order to obtain cash. Let investor 5 be an extraneous, special class of investor (a hedge fund, bank with longer term liabilities, or private equity group) with a different risk appetite than investors 1-4. For the simplicity of this model, investor 5 (and others of its class) prefers to purchase assets at depressed prices in order to achieve higher returns. By purchasing assets from at-risk institutions, the special investor shores up a potential liquidity crisis and hopes to eventually profit from the asset purchase. Though this seems logical and beneficial, it also distorts the soundness of the chain.

Because institutions C and D sold their assets after the initial shock, they were forced to sell a fraction *d* of their assets such that $dZ(P) = fC$, where *f* is the proportion of the cash obligation *C* that must be paid (i.e. a margin call) so that

$0 \le f \le 1$. Thus, $d = \frac{fC}{ZP}$; d cannot be greater than 1, or the bank would be insolvent and cease operation. The institution's payoff from selling at time zero (with probability q that their sale pays off the cash obligation) is: $q[(1-d)Z-(1-f)C]+(1-q)[Z-C]$, which simplifies to $Z-C-qfC(\frac{1}{P}-1)$ after substituting for d[110]. Thus, the institutions have paid a premium, or "illiquidity cost," of $qfC(\frac{1}{P}-1)$ by selling for $P<1$, as is often the case when margin calls grow in the face of a crisis.

The asset sale triggers a range of troubling implications. Because two of the institutions engaged in a large-scale asset sell-off, they are more at-risk than the remaining institutions that were not forced into selling because they no longer have the option to sell assets in light of a liquidity shock. This also means that the entire chain is more vulnerable because it contains firms that have previously suffered from liquidity shocks. Moreover, a massive asset sale of this scale combined with liquidity concerns would also trigger further price depression. This realization also has stark implications for the rest of the institutions in the chain because if they choose to engage in an asset sale, they will have to sell off a higher fraction of their total assets to meet cash obligations than did the first two firms. It is clear that this asset sale will have inherently increased the instability of the chain and the entities within it.

[110] Douglas W. Diamond and Raghuram G. Rajan (2009): "Fear of Fire Sales and the Credit Freeze," a National Bureau of Economic Research Working Paper (14925).

Let Figure 3 (above) depict *T = -1* so that the chain model we are examining has already weathered a liquidity shock and two of its institutions have sold off assets so as to remain operable. At *T = 0*, these institutions have attracted new financing from a "normal" investor and the chain has been repaired. However, they are also limited in their ability to recover from another liquidity shock—their new, diminished asset base (*Z'*) is smaller than the amount of cash needed to meet payment obligations.[111] Thus the chain is more susceptible *ceteris paribus* having already weathered a liquidity shock.

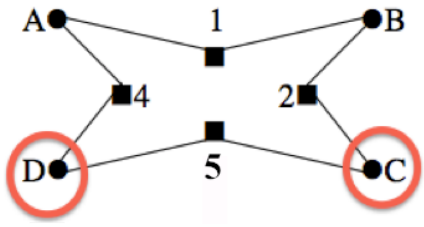


Figure 9: An Unstable Chain

Timeline:

T = -1	➔	*T = 0*
Shock hits investor 3	C and D sell assets to raise cash	Chain repaired, but unstable

Institution Types

Though institutions and investors are identical prior to any shocks, they become heterogeneous after shocks hit the chain. In this case, as a function of their position in the chain, institutions have different expected utilities.

[111] In this case, as with both LTCM and Bear Stearns, it would be extremely prudent to raise cash by another means—an equity offering or other external investment, regardless of any premium paid due to market depressions or liquidity fears.

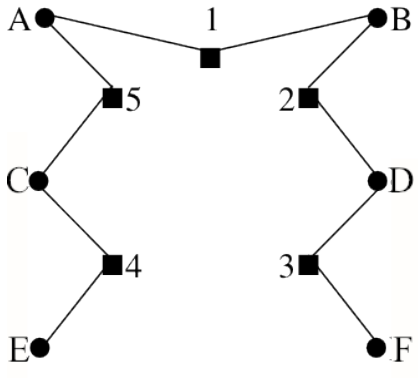


Figure 10

Institution F in the figure above is an endpoint institution that is "at-risk." It will fail during the next period due to a lack of funding unless management opts to sell assets and increase liquidity. Institution F's expected utility is: $E(U)_F = U[(1-b)[(1-d)Z](1+\beta)^n - b(vZ)]$ where b is the probability that the firm defaults and its converse, $1-b$, is the probability that the firm sells assets to increase liquidity. Here v is the bankruptcy return on assets Z, $(1-d)Z$ represents the asset base not sold to raise cash, and $(1+\beta)^n$ is the utility return gained by surviving n periods.

Institution C is a borderline institution. This institution is not immediately at risk, but faces the withdrawal of an investor in the following period. These institutions have a normalized current expected utility of $E(U)_C^{N=0} = U[Z(1+\beta)^n]$, given that it will not be forced to sell assets this time period. Next period, C will become "at-risk" institutions and face the expected utility of an endpoint institution: $E(U)_C^{N=1} = U[(1-b)[(1-d)Z](1+\beta)^n - b(vZ)]$. This probable future instability must be accounted for in current

expected utility. The term $\frac{1}{\pi}$ (where π stands for the term $(1-b)[(1-d)Z](1+\beta)^n - b(vZ)$ will allow for the expected future position of the institution. Thus, firm C's current expected utility as depicted in Figure 4 will be $E(U)_C^{N=0} = U[Z(1+\beta)^n + \frac{1}{\pi}]$.

Finally, institution A (and B) in the diagram represents interior (or shielded) institutions. They will not face significant risks for two—or more—periods. Thus, these institutions' utility equations are similar to those of borderline investors, with a small tweak. The term $\frac{1}{\pi}$ must be altered to consider the relative length of time that an interior firm will spend being stable with reliable sources of financing. To account for this stability, the term π is squared because the contagion is (more than) two periods off, with exponentially less risk involved. This results in the utility function for an interior (safe) institution as follows $E(U)_C^{N=0} = U[Z(1+\beta)^n + \frac{1}{\pi^2}]$.

Scenario 1—No Interaction

Assume another shock hits the chain at $T = 0$. In this simple chain, with 4 institutions and 4 investors, the probability of an iid shock hitting one of the susceptible institutions is .25. If a shock were to hit one of the less-stable institutions or one of their sources of financing, they would be unable to engage in an asset sale to stave off insolvency. Let us project a shock that hits investor 2 at $T = 0$ so that institutions B and C would both lose a source of financing. Firm

C, having already weathered a liquidity shock and sold off a large portion of its assets, will become insolvent due to a lack of financing and excessive leverage. Because C will default on its payment obligations to investor 3, investor 3 will withdraw financing from institution D at $T = 1$ (in order to reallocate from an undiversified risky portfolio to one comprised of safer assets). Institution D will suffer the same fate as institution C (it had already suffered an asset sell off as well) at $T = 1$.

Let us assume that the asset market in this model has an enlarged bid-ask spread, such that the "ask" price sellers demand is much higher than potential buyers' "bid" prices. This is a direct consequence of the fire sale that occurred when Institutions C and D rapidly sold off large amounts of their assets. Institution B, having lost one of its two fundamental sources of financing (investor 2) in another shock, must engage in a massive sell off of its assets in order to meet payment obligations to investor 1. Unfortunately, B must sell at a further depressed price P_1, such that $P_1 < P_0 < 1$, where 1 is the return on the asset if held to maturity. While C and D sold their assets for $d_0 Z(P_0) = fC$ or $d_0 = \frac{fC}{ZP_0}$ where C was their payment obligation and f was the proportion of the obligation due, B must sell for $d_1 Z(P_1) = fC$ or $d_1 = \frac{fC}{ZP_1}$, where $d_1 > d_0$. While C and D paid an illiquidity cost of $fC(\frac{1}{P_0} - 1)$, B will pay $fC(\frac{1}{P_1} - 1)$. Thus, B must sell a larger proportion of its assets to meet its liquidity demand due to depressed asset

prices. Despite institution B's financial health prior to the second shock, the fire sale that began with institutions C and D has threatened both its liquidity and solvency.

Timeline:

T = -1	➔	*T = 0*	➔	*T = 1*
Shock hits investor 3	C and D sell assets to raise cash	Chain repaired, but unstable	C defaults, investor 5 withdraws	Investor 4 withdraws
		Second shock hits investor 2	D defaults, B sells assets	
➔	*T = 2*	➔	*T = 3*	
A defaults (asset market illiquid)	Investor 1 withdraws	B defaults	Total chain collapse	

Depending on the size of the chain and the extent of the fire sale of assets that has occurred prior to this point, it is possible that the asset prices have decreased enough so that selling is no longer a viable option for a troubled institution. Due to extreme leverage, it is likely that their payment obligations vastly exceed the amount of cash they could expect to earn by selling assets. This scenario could occur near the end of an extended liquidity crisis. Surviving institutions and their investors may face the specter of insolvency without the choice of whether or not to sell assets.

Institution A has the option to engage in a preemptive asset sale. With foresight, institution A could sell assets at the same time as institution B (at $T = 1$) in response to the shock. Institution A would face price P_1 for a sale at $T=1$ (remember: $P_1 < P_0 < 1$, where 1 is the return guaranteed by holding assets to

maturity) and pay illiquidity cost $fC(\frac{1}{P_1}-1)$. However, because A did not lose a lender prior to selling assets, it also pays the opportunity cost of holding cash instead of return-generating assets: R(*dZ)* = 0, where *dZ* is the proportion of assets sold. Thus, A would sacrifice the return on *dZ* of its assets by selling preemptively. Though a sell off would protect A from single lender failure, it would not prevent default if both of A's lenders collapse, which is a distinct possibility. It also diminishes the firm's short-term profitability (the firm would sell a portion of its return-generating assets at depressed prices and thus hold excess cash reserves for an unspecified period). Under the established preferences, management will maintain a microprudential strategy and abstain from an asset sell-off to protect against what may be an impaired financing chain[112].

In this chain, which explores the effects of a fire sale, expected utilities vary wildly between institutions. Firms C and D, who already sold a portion of their assets to raise liquidity, have an expected liquidity of $E(U)_C^{T=0} = U[(1 - q)[(1 - d)Z](1 + \beta)^n - q(vZ)]$, where q is the probability of a shock hitting the institution (or one of its investors) at the next date. This measure is extremely similar to that of an "endpoint" investor, though these institutions have already sold off a portion of their assets and will default apropos of a funding withdrawal. Institutions A and B, however, have expected utility functions $E(U)_A^{T=0} =$

[112] The transient nature of management roles and executive compensation structures at Wall Street institutions dramatically emphasizes short-run profitability over long-run viability.

$U[Z(1+\beta)^n + \frac{q}{\pi}]$, where q represents the probability that a shock will strike the chain next period (and thus A or B—or both—will become endpoint investors).

The "fire sale externality"—where "each individual institution takes potential fire sale prices as given, while as a group they cause [depressed] prices"[113]—that exists in this model leads to Pareto inefficiency and market failure. This doomsday scenario will not occur if institutions develop an avenue for communication and cooperation. If institutions A and B communicate, they can jointly appeal for influxes of investment and stabilize their financing situation. Theoretically, this solution can occur at any point in the chain as long as some medium of firm-to-firm interaction exists.

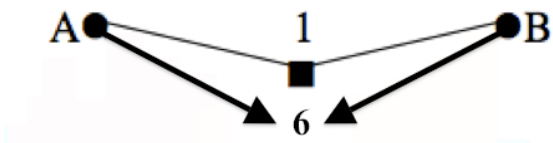


Figure 6

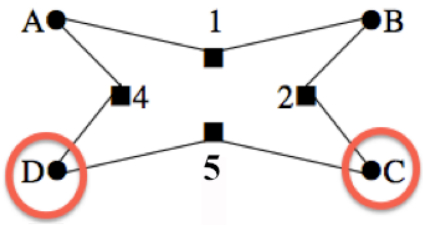
The most effective and logical avenue for inter-firm cooperation is the government (specifically the Treasury Department and Fed). Public finance theory stipulates that a government should correct for market failures and scenarios such as this—when financial stability is tenuous—are no exception.

Scenario 2—Government incentive

Let us assume that the government plays a role in mitigating the liquidity

[113] Tobias Adrian and Markus K. Brunnermeier (2010): "CoVar," a Federal Reserve Bank of New York working paper.

crisis. This altered scenario will also begin at $T = 0$ following a liquidity shock at $T = -1$, which prompted institutions C and D to sell assets (recall Figure 4) at $T = 0$ to meet payment obligations:



Institutions A and B in this scenario now have the option and incentive to sell assets in advance of a liquidity shock (with knowledge that one already occurred). A and B will sell assets after $T = 0$ prompted by C and D's sale after a shock at $T = -1$. In this scenario, the government will guarantee A and B asset prices higher than the fire sale price they would expect to receive in an illiquid market. Having raised cash provisionally, these two institutions will be prepared for a liquidity shock at $T = 1$, which may or may not occur. C and D sold $d_0 = \frac{fC}{ZP_0}$ of their assets and A and B will sell $d_1 = \frac{fC}{ZP_1}$. At $T = -1$, C and D paid an illiquidity cost of $qfC(\frac{1}{P_0} - 1)$. Government intervention in the asset market will allow A and B to sell for asset price P'_1 such that $P_0 \leq P'_1 < 1$. Thus, institutions A and B pay a liquidity cost of $(\frac{1}{P'_1} - 1)fC$, which is a premium over the market price P_1 and an incentive to sell assets as a precaution[114]. This injection of cash into the financial

[114] Price P'_1 must be greater than or equal to the expected return on assets forgone. XX

sector can be likened to the TARP[115] facility employed by the Bush administration in 2008—wherein the Treasury paid a premium to take "troubled assets" off of institutional balance sheets—except that the asset sale occurs prior to a second shock.

This intervention provides institutions A and B with enough cash on hand to pay off cash obligations that arise due to a liquidity shock at *T = 1*. Unfortunately, it does nothing to shore up the troubled balance sheets of institutions C and D. Shocks to either institution or any of their investors—2, 4, and 5—will result in massive defaults across the board (as in scenario 1) and culminate in Figure 6:

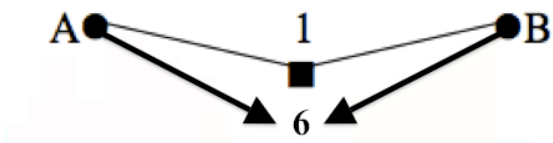


Figure 6

Timeline:

T = -1	➔	*T = 0*	➔	*T = 1*
Shock hits investor 3	C and D sell assets to raise cash	Chain repaired, but unstable	A and B sell assets preemptively	Shock hits either damaged institution
➔	*T = 2*			
C and D default; investor 5 fails	A and B acquire new financing			
Investors 2 and 4 withdraw	Investor 6 enters chain			

[115] The Troubled Asset Relief Program (TARP) stipulated the government purchase of assets and equity from many notable financial institutions so as to stabilize the financial sector in light of the subprime mortgage crisis in 2008.

This government intervention significantly alters the measure of expected utility for certain firms in the chain. C and D, previously stricken by liquidity shocks, have the same expected utility functions at T = 0 as in the fire sale externality scenario116. However, institutions A and B realize different expected utility functions given the government incentive to sell assets prior to a shock. The expected utility function for institution A (and B) is as follows: $E(U)_A^{T=0} = U[(1-b)[xZ-(1-x)(1-d)Z+gdZ](1+\beta)^n - b(vZ)]$, where x is the probability that A sells assets prior to a liquidity shock and gdZ, which is the benefit received (g, above market price) for assets sold (dZ) preemptively. If Z < $(1-d)Z+gdZ$, the institution will sell preemptively. Otherwise, it will accept the risk of a shock because it realizes more utility in the current period by maintaining its asset base.

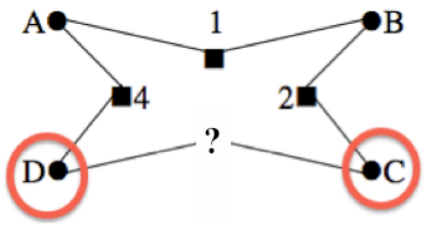
Though the asset sale and cash injection has insulated institutions A and B from the domino-like collapse of their peers, the surviving institutions may face a credit freeze and extremely unfavorable asset values. A and B will have enough cash on hand to pay obligations and continue to operate until they can secure a different means of financing at period $T = 3$. It is very likely that they will pay a high premium for term financing, if it is available at all. The failure of two high profile banking institutions will have had stark implications for the financing market, as risk profiles of survivors will appear murky at best. Though this government intervention successfully abated widespread contagion, it

[116] $E(U)_C^{T=0} = (1-q)[(1-d)Z \cdot U](1+\beta \cdot U)^n - q(vZ \cdot U)$, where the institution will fail if hit by a shock (with probability q), but maximizes the utility of (1-d)Z assets otherwise.

significantly depleted the industry and required the government to purchase depressed assets at a large premium over market price. The results of this exercise demand exploration of other governmental interventions.

Scenario 3—Government as conduit

Instead of purchasing troubled assets at high premiums to stave off instability, governments may "guarantee" loans for at-risk institutions. By putting the weight of the government's balance sheet behind a firm's finances, the government may be able to prevent a fire sale and the widespread default characteristic of scenarios 1 and 2. Once again, this scenario will begin at $T = 0$ following a shock at $T = -1$, wherein investor 3 failed and institutions C and D lost a source of financing—as in Figure 7 below:



The government, fearing the systemic repercussions of an idiosyncratic shock, will attempt to shore up institutional liquidity by stepping in to extend and guarantee funding. Instead of engaging in an asset sale, troubled institutions (such as C and D) receive lines of credit from the government and post their assets as collateral. In this case, the government replaced investor 3 as a source of financing for institutions C and D. Moreover, the government will guarantee the troubled institutions' loans to investors 2 and 4. This strategy prevents

extreme downward pressure on already depressed asset prices by precluding an asset sell off.

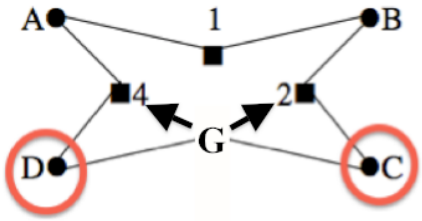


Figure 7

The introduction of government as lender dramatically transforms the nature of the chain. Because the government is interminably secure, the other investors in the chain will benefit from improved confidence and the knowledge that the probability of a collapse has decreased significantly. At the same time, the market or financial sector as a whole may stigmatize those in receipt of government support, considering it a sign of weakness. In reality, this is a logical assumption founded on substantial evidence. However, in this model, by guaranteeing "at-risk" loans, the government implicitly secures investors 2 and 4 from the danger that C or D suffers a shock. The so-called "stigma" of government investment will not be addressed in this model. In the eyes of their peers, the "at-risk" institutions (under the auspices of government intervention) have reclaimed the characteristics of a non-troubled institution. It must be noted that the government will not bankroll these institutions "forever." It is a suboptimal strategy for the government to "nationalize" banking institutions for a multiplicity of reasons. For the effects of the intervention to have its full effect;

however, the government must not disclose its financing timeframe. This intervention strategy alleviates the downward pressure on prices characteristic of a fire sale and prevents contagious collapse.

Institutional expected utilities change significantly when the government introduces this intervention. By guaranteeing funding to troubled institutions, the government attempts to prevent a liquidity crisis from threatening the financial sector's stability. "At risk" institutions C and D have expected utility $E(U)_C^{T=0} = U[(1-b)\cdot Z\cdot\left(1+\frac{\beta}{\sigma}\right)^n - b(vZ)]$, where $\left(1+\frac{\beta}{\sigma}\right)^n$ is the survival utility return given government financing (σ deflates the survival multiplier because a portion of future earnings must be used to repay the government).

Scenario 4—Industry-led Bailout

The government may also choose to play a less obvious role in mitigating systemic contagion. As it did in 1998 in response to the LTCM collapse, the government could informally organize an industry-led bailout of "at-risk" firms. That is, the Treasury and Fed could employ their substantial authority to induce some sort of agreement among healthier institutions to guarantee the survival of an "at-risk" institution. This follows from the scenario 1 assertion that it may be in healthier firms' best interest to rescue a troubled firm. Without an effective means of communication, firm preferences dictate that an industry-led bailout would never occur. However, if the Fed or Treasury can assemble management teams from concerned parties, the government may be able to spur a concerted

effort to expand liquidity and protect the industry from systemic risk spillover. Will firms pledge a portion *mZ* of their assets to guarantee that an "at-risk" institution does not fail and collapse a susceptible chain?

Let us once again assume that a shock hit investor 3 at *T = -1* and spurred a liquidity crisis for institutions C and D (as in Figure 7). Institutions C and D will now be considered "at risk" endpoint institutions, with expected utility functions $E(U_{Risky})_{k=4}^{T=-1} = U[(1-b)[(1-d)Z](1+\beta)^n - b(vZ)]$.

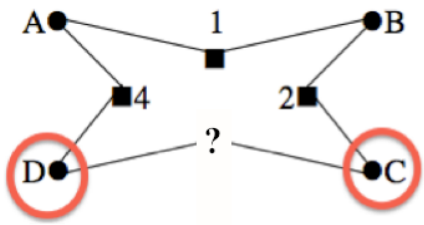


Figure 7

The government, in order to prompt a private "rescue"—or sale, must convince the other firms that they will gain utility by helping "at risk" institutions. Though institutions A and B have a vested interest in the continued survival of the financing chain, there is a free rider problem. Each firm would prefer not to engage in a private bailout, but *would* prefer to benefit from a private bailout spearheaded by its competitor. The government, in its stabilizing role, must convince both institutions that a two-party private rescue is mutually beneficial for both of them. Thus, the Fed and Treasury would insist that A and B's expected utility functions are not $E(U_{Healthy})_{K=4}^{T=-1} = U[Z(1+\beta)^n - \frac{q}{\pi}]$, but actually $E(U_{Healthy})_{K=4}^{T=-1} = U[Z(1+\beta)^n - q(\frac{1}{\pi}|_{NoBail}, (M - \frac{\theta}{K-K_R})|_{PrivBail}]$ where M

is a measure of the potential benefit gained by a rescue and $\frac{\theta}{K-K_R}$ is a measure of the potential cost spread over participatory institutions. Healthy firms will participate in the bailout as long as $M > \frac{\theta}{K-K_R}$. If $M < \frac{\theta}{K-K_R}$, the government will provide "savior" firms an additional incentive until the potential benefits outweigh the potential costs.

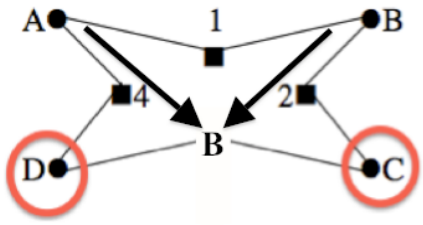


Figure 8

It must be noted that this sale may also occur at the behest of an institution not included in the financing chain. In this case, the troubled firm in question will be removed from the chain upon acquisition. Though this solution is optimal to default, it leaves two investors with suboptimal portfolio allocations unless the troubled institution's loans are guaranteed either by its acquirer or another party. In this case, the potential "savior" firm will have an expected utility function $E(U_{Outside})_{K=4}^{T=-1} = U[Z(1+\beta)^n - q(\mu|_{NoBail}, (M-\theta)|_{PrivBail}]$, where μ is the potential harm from an institutional default and $M - \theta$ is the benefit of the acquisition less its cost.

If another shock hits the chain at $T = o$, all firms in the chain will be able to engage in an asset sell off at less-depressed market prices than if C and D had been forced to sell assets prior to the second shock. Moreover, as a result of the

industry-led bailout, C and D will not fail after a second shock hits the chain. This is the optimal strategy for the government, in that it does not have to put its own balance sheet at risk by purchasing assets or guaranteeing loans for troubled institutions. Instead, other financial institutions will "foot the bill" so to speak because otherwise they would face a liquidity shortage and fire sale. Obviously, the financial sector would prefer scenario 3 (direct government bailout), but at the government's prerogative, it should elect to induce an industry-led bailout.

2.2

THE SUBPRIME CRISIS

This examination of the 2008 crisis will employ the modified Lagunoff-Schreft model previously expounded to evaluate the government's attempt to prevent a systemic collapse. I will explore the chain of events that occurred following the collapse of Bear Stearns by evaluating the effects of the government's decisions.

Table 1—Institutions (as of January 2008)

Bank Holding Companies	Ticker Symbol
Bank of America Corporation	BAC
Citigroup	C
JPMorgan Chase and Company	JPM
Wachovia	WB
Wells Fargo and Company	WFC
Investment Banks	**Ticker Symbol**
Bear Stearns Companies	BSC
Goldman Sachs Group	GS
Lehman Brothers Holdings	LEH
Merrill Lynch and Company	MER
Morgan Stanley	MS

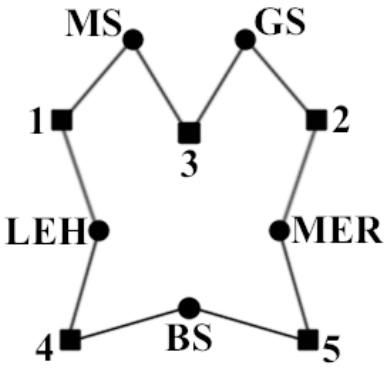


Figure 9: US Broker-Dealers[117]

When the federal government rescued Bear Stearns in March 2008, it guaranteed a secured line of financing while JPMorgan finalized its acquisition. Interestingly, Steve Black, co-head of Morgan's investment bank, was quoted a month prior to the Bear deal as saying that a Morgan investment banking acquisition would have to occur "over his dead body."[118] By exerting their tremendous influence and appealing to Jamie Dimon's sense of history, Hank Paulson and Tim Geithner deftly arranged for JPMorgan to takeover Bear, but sweetened the deal with guaranteed term financing to keep the firm afloat during the takeover period. Thus, the Fed's organized sale of Bear Stearns to JPMorgan corresponds to Scenario 4 of the modified Lagunoff-Schreft model. The government organized a private bailout of a troubled firm (one that had suffered a shock—in this case, a severe liquidity shock), but needed to employ its own balance sheet as an incentive to ensure a viable deal.

[117] A combination of leverage ratios and shareholder's equity are the logical basis for the organization of this chain: in late 2007, Bear Stearns operated with a leverage ratio of 34:1 and a market
[118] Lowenstein (2010): *The End of Wall Street.*

In the period leading up to the deal, Bear Stearns faced a massive cash crunch and run on its accounts. Bear Stearns had an expected utility function similar to that of an "at risk" institution, where $E(U_{BSC})_{k=5}^{T=-1} = U[(1-b)[(1-d)Z](1+\beta)^n - b(vZ)]$. At *T = -1*, Bear's only options are: bankruptcy, denoted by the term *b(vZ)* and an asset sale, denoted by $(1-b)[(1-d)Z](1+\beta)^n$. As its capital reserves decreased and stock price plummeted, the probability of a failure and bankruptcy (b) began to increase dramatically, until the government—and JPMorgan—stepped in to ensure the firm's survival.

Between *T = -1* and 0 (the date of the rescue), the Fed convinced Morgan leadership that the potential damage of a Bear default would vastly outweigh the costs of the costs of acquiring the troubled investment bank. Moreover, the Treasury offered the support of its balance sheet as an incentive and stabilizing measure. JPMorgan's utility function at the time of the sale ($T = 0$) would have changed from that of an insulated firm at *T = -1*—$E(U_{JPM})_{K=5}^{T=-1} = U[Z(1+\beta)^n - \frac{q}{\pi}])$. At $T = 0$, JPMorgan's utility function becomes $E(U_{Outside})_{K=4}^{T=-1} = U[Z(1+\beta)^n - q(\mu|_{NoBail}, (M-\theta)|_{PrivBail}]$. At this point, it is important to note that JPMorgan is not an institution in the broker-dealer chain due to its deposit-taking, banking conglomerate status. By acquiring Bear Stearns, JPMorgan effectively removed them from the broker-dealer chain, while the government guaranteed their loans for a limited period. Thus, at $T = 0$,

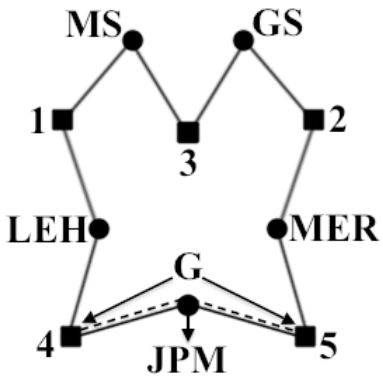


Figure 10: Post-Bear acquisition (*T=0)*

The bailout exacerbated the credit crunch to such an extent that the Fed opened its discount window to the remaining investment banks in an effort to restore liquidity to the system. Thus, the Fed set two unlikely precedents in March: the Bear rescue *and* the "blurred distinction" between commercial and investment banks.[119]

Bear Stearns' absence altered the landscape of investment banking significantly. Lehman Brothers and Merrill Lynch became the most vulnerable links in the Wall Street chain. Both firms engaged in a concerted effort to trim assets and increase liquidity. The investment banks are in an open chain following Bear Stearns' collapse and sale to JPMorgan Between $T = 0$ and $T = 1$, investors 4 and 5 will withdraw from the financing chain and reallocate their undiversified portfolios entirely into the safe asset. By virtue of their asset sale, Lehman Brothers and Merrill Lynch can attract a new investor to provide term

[119] Lowenstein (2010): *The End of Wall Street.* Paulson, Bernanke, and Geithner's rationale was that every advanced banking firm (depository or not) was linked due to the widespread use of derivatives.

financing (as in Figure 11 below).

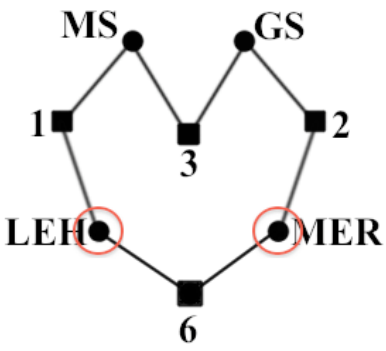


Figure 12

Having sold off a portion of assets to increase capital reserves and secure financing, Lehman and Merrill find themselves highly susceptible to a downturn in the credit markets. Their utility functions should resemble that of the "at-risk" institutions articulated in the model, such that $E(U_{LEH,MER})_{K=4}^{T=1} = U[(1 - b)[(1 - d)Z](1 + \beta)^n - b(vZ)]$. However, the precedent set when the Fed bailed out Bear Stearns systematically alters the preferences and utility functions of these at-risk institutions. Given the Bear Stearns precedent, wherein the Fed supported a troubled investment institution with the full weight of its balance sheet, Lehman and Merrill operate with the reasonable expectation that they too could expect some sort of government intervention in the face of collapse. Thus, the two ailing investment banks would have utility functions at $T = 1$ of $E(U_{LEH,MER})_{K=4}^{T=1} = U[(1 - b)Z\left(1 + \frac{\beta}{\sigma}\right)^n - \frac{b}{\varepsilon}(vZ)]$, where $\frac{\beta}{\sigma}$ is a measure of the firm's survival, divided by the government's stake (which must be repaid), and $\frac{b}{\varepsilon}$

is the probability of a shock-induced default (which has been dramatically reduced by a governmental rescue ε). This utility equation allows for the firms' reasonable assumption that the government will have a hand in forestalling financial contagion. Because the $\frac{b}{\varepsilon}$ measure has significantly reduced the probability of failure, Lehman Brothers and Merrill Lynch will resume operations "as normal" despite their tenuous positions. They reasonably expect that the government will provide assistance in case of some shock in the future.

Unfortunately for Lehman Brothers and Merrill Lynch, a second shock did occur, albeit sometime later. For the simplicity of the model, let us assume that the second shock occurs at $T = 3$.[120] In the time between $T = 1$ and $T = 3$. The value of Lehman and Merrill's capital had diminished considerably. When it attempts to secure financing at $T = 2$, Lehman's credit rating and asset base are nearly impossible to borrow against due to the declining value of its assets. At $T = 2$, investor 6 secures lines of credit to LEH and MER (despite their lack of liquidity and collateral-worthy capital), but insists that it will reallocate its portfolio to the safe asset at $T = 3$, which will spawn an open chain (as in Figure 12).

[120] In reality, the second shock occurred in September of 2008, about 5 months after the collapse of Bear Stearns in March. On September 7th, when Hank Paulson released surprising legislation that placed Fannie Mae and Freddie Mac into a government conservatorship. Though markets rallied on the 8th, credit markets tightened the following day and almost all of Lehman's stock changed hands. Once confidence evaporated, the firm suffered a run on its accounts, which crippled its capitalization.

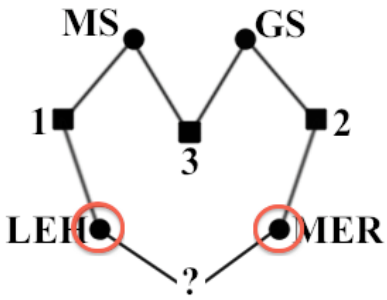


Figure 112

Between $T = 2$ and $T = 3$, both firms will attempt to raise capital privately, which is preferable to the stigma that accompanies a government "bail out." Thus, Lehman Brothers and Merrill Lynch have utility functions:

$$E(U_{LEH,MER})_{K=4}^{T=2} = \begin{matrix} U_G\left[(1-b)Z\left(1+\frac{\beta}{\sigma}\right)^n - \frac{b}{\varepsilon}(vZ)\right]|govrescue \\ U_P\left[(1-b)Z\left(1+\frac{\beta}{\sigma-\lambda}\right)^n - \frac{b}{\varepsilon-\rho}(vZ)\right]|privrescue \end{matrix}$$

$\frac{\beta}{\sigma-\lambda}$, the survival metric divided by the profits due to rescuer, is smaller in for a private deal than a government deal. At the same time, the probability of a default $\frac{b}{\varepsilon-\rho}$ is higher for a private rescue, because private firms are much more likely to fail than the US government. In either case the normalized probability b of "at-risk" firm failure is much greater than $\frac{b}{\varepsilon}$ or $\frac{b}{\varepsilon-\rho}$, which are the probabilities in Lehman and Merrill's utility functions given the bailout precedent.

At $T = 3$, Lehman is unable to reach a deal with a private investor or other firm. Merrill, on the other hand, consummates a deal with Bank of America (BAC), a large corporate bank. Bank of America pledges mZ assets to acquire

Merrill Lynch at $T = 3$ (Bank of America did not require or request any federal assistance when it acquired Merrill). Because it operated under the assumption that a bailout would come either privately or publicly, Lehman failed to account for the real possibility of bankruptcy. Thus, the realized probability that Lehman would fail b is much higher than anticipated at $T = 3$. Lehman's *expected* utility function[121] at $T = 2$ failed to account for a scenario where the firm would not be rescued. Lehman's actual utility function at $T = 2$ should have incorporated the risk of an actual default scenario.[122]

Barclays Capital, a British bank, indicated that it would have acquired Lehman Brothers[123] had the Fed stepped in and guaranteed Lehman's obligations for an interim period while Barclays' shareholders approved the deal. The Fed, however, refused to employ its balance sheet power to rescue Lehman and the firm went bankrupt on September 15, 2008. Lehman defaulted on $600 billion, which shook credit markets to their core. It was the largest bankruptcy in the history of the United States.[124]

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[121] $E(U_{LEH,MER})_{K=4}^{T=2} = \begin{matrix} U_G\left[(1-b)Z\left(1+\frac{\beta}{\sigma}\right)^n - \frac{b}{\varepsilon}(vZ)\right] | govrescue + \\ U_P\left[(1-b)Z\left(1+\frac{\beta}{\sigma-\lambda}\right)^n - \frac{b}{\varepsilon-\rho}(vZ)\right] | privrescue \end{matrix}$

[122] Wall Street executives were surprised to learn that the government would let Lehman fail and worried about the repercussions of its bankruptcy. As Lehman tottered, Jamie Dimon, JPMorgan's CEO, expressed a palpable concern: he warned Morgan's risk manager that he should prepare for the failure of Lehman Brothers, Merrill Lynch, Morgan Stanley, and Goldman Sachs!

[123] Barclays PLC acquired Lehman's operations outside of the United States in fall 2008.

[124] On the 15th, the Dow plummeted 504 points, the interest rate on 30 day T-bills dropped to a fifth of a percent, and Morgan Stanley's stock declined 23%.

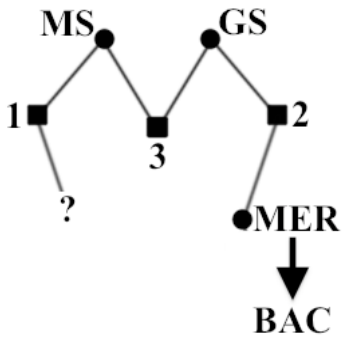

Figure 12

On September 16th, disruptions caused by Lehman's bankruptcy forced the US government to bail out American International Group, who was deemed too systemically important to fail. The Fed effectively nationalized AIG, the leading originator of credit default swaps (and thus insurer of Wall Street's CDOs and mortgage portfolios). Regulators came to the determination that AIG's "underlying businesses were more enduring than Lehman's, its collateral was more secure, and it was a better credit risk."[125] Moreover, Paulson and other government officials feared that the "indirect but systemic effects of an AIG collapse would send a second Lehman-style tidal wave over Wall Street."[126] Realizing that it had not accounted for the devastating fallout of Lehman's failure, the Fed quickly abandoned its crusade against moral hazard and threw its support behind a troubled insurance giant. Ironically, Paulson extended loans to the hollowed-out shell of Lehman Brothers that would allow its assets to be purchased by Barclays. By Tuesday night (September 16th), Morgan Stanley faced

[125] Lowenstein (2010): *The End of Wall Street.*
[126] Lowenstein (2010): *The End of Wall Street.*

an onslaught of hedge fund withdrawals and stark undercapitalization.

With Lehman gone and Merrill in the hands of Ken Lewis and Bank of America, Wall Street was left with two wavering broker-dealers. Paulson and Geithner implored that they convert themselves into bank holding companies and requested that both firms evaluate possible mergers with commercial banks, Goldman with Wachovia and Morgan Stanley with JPMorgan or Citi. As the financial system quivered on the brink of destruction and credit markets froze, the Fed acted to circumvent systemic contagion and announced that it would inject a massive chunk of capital into the financial sector. Unfortunately, Congress was unready and for the most part unwilling to approve a large taxpayer bank bailout at that time. The two remaining broker dealers secured investments from private sources: Morgan Stanley from Japanese bank Mitsubishi UFJ and Goldman from Warren Buffett.

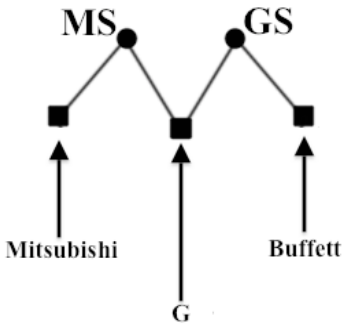

Figure 13: Goldman and Morgan Stanley

In terms of the model, at $T = 4$ the government has stepped in to provide funding for the broker-dealers and they have acquired new financing from private

sources. Both firms have satisfied their $T = 4$ expected utility functions, with both private and public financing.

$$E(U_{MS,GS})_{K=2}^{T=4} = \begin{matrix} U_G\left[(1-b)Z\left(1+\frac{\beta}{\sigma}\right)^n - \frac{b}{\varepsilon}(vZ)\right]|pubrescue + \\ U_P\left[(1-b)Z\left(1+\frac{\beta}{\sigma-\lambda}\right)^n - \frac{b}{\varepsilon-\rho}(vZ)\right]|privinv \end{matrix}$$

With TARP up for debate on Capitol Hill, Washington Mutual suffered a bank run and went bankrupt on Thursday, September 25th. The government seized the troubled retail bank and sold it to JPMorgan, but neither Morgan nor the government repaid WaMu's debt. The final tally of bailouts and non-bailouts was extremely complicated. The government guaranteed Fannie Mae and Freddie Mac's obligations, Lehman had defaulted on its debt, AIG had been supported by the government, and now Washington Mutual debt holders had been thrown to the wolves. At the same time, Wachovia began to suffer a run on its accounts and considered offers from both Citigroup and Wells Fargo. Wachovia balked at Citi's offer, Wells acquired Wachovia, and Citigroup's stock began to plummet. On October 2nd, the Dow fell 350 points under the stress of Citi's instability and undercapitalization. Fearing a systemic collapse and the wrath of the American people, the Senate and House approved the TARP. Asset prices, especially mortgage securities, continued their slide.

The first two weeks of October wreaked havoc on financial markets across the globe. The financial system suffered from a massive shortage of capital.

The first two weeks of October wreaked havoc on financial markets across

the globe. The system suffered from a massive shortage of capital. On the 9th, the market crashed again—by a mind-numbing 679 points. Investors flocked to "safe" treasuries and sent financial stocks plummeting. The rate for 30-day T-bills "plunged to a microscopic five one-hundredths of a point."[127] The fickle market brought Morgan Stanley to its knees—its shares hovered around $10, a twelve year low. Prompted by European debt guarantees on Sunday morning (the 13th), Paulson abandoned his crusade against moral hazard and convened a financial roundtable at the Treasury Department.

Along with Sheila Bair, Ben Bernanke, and Tim Geithner, Paulson insisted that a recovery package guarantee bank debts so as to mirror the European proscription. Without a guarantee, they could not be sure that lenders would accept banks as counterparties. The guarantee effectively meant that bank holding companies and savings-and-loans to refinance outstanding debt with new, federally guaranteed debt with a three-year term. This move allowed banks to "raise money at a much lower cost, as lenders would not have to worry about default risk."[128] The likes of Bank of America, BNY Mellon, Citigroup, Goldman Sachs, JPMorgan Chase, Merrill Lynch, Morgan Stanley, State Street, and Wells Fargo were represented at the Treasury (the nine largest financial institutions in the country). Paulson alerted the CEOs of his plan and pledged $250 billion to the US banking industry, with $125 billion allocated to the nine biggest firms.[129]

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[127] Lowenstein (2010): *The End of Wall Street.*
[128] Lowenstein (2010): *The End of Wall Street.*
[129] Citi received an additional $20 billion in TARP funds on November 24th. Its market capitalization in November fell to about $6 billion (down from a historical high of $244 billion). The government

The financial system was finally afloat and buoyed by an abundance of capital.

The remaining specialized broker-dealers, Morgan Stanley and Goldman Sachs, became bank holding companies. By transforming into BHCs, these firms received the TARP's capital injection and lending facility.

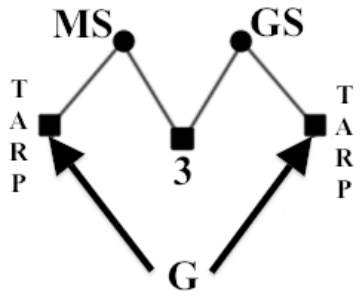

Figure 13

Thus, the broker-dealer chain modeled in this chapter effectively disappeared during the fall of 2008. JPMorgan acquired Bear Stearns, Wells Fargo purchased Wachovia, Bank of America collected Merrill Lynch and Countrywide Financial, and Goldman and Morgan Stanley effectively joined the ranks of the commercial banks. Wall Street, as it had previously existed (and prospered), is no longer recognizable.

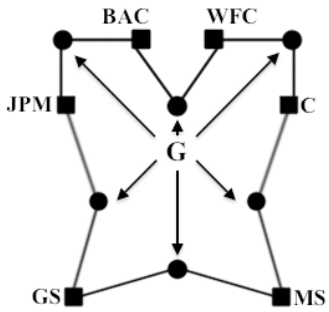

Figure 14: Present System

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also pledged to cover 90% of its losses on a $300+ billion mortgage portfolio in exchange for substantial control and $27 billion in preferred equity.

Table 2—US Bank Aggregation (as of January 2008)

Bank Holding Companies	Ticker Symbol
Bank of America Corporation + Merrill Lynch & Co.	BAC
Citigroup	C
JPMorgan Chase and Company + Bear Stearns	JPM
Wells Fargo and Company + Wachovia	WFC
Goldman Sachs Group	GS
~~Lehman Brothers Holdings~~	~~LEH~~
Morgan Stanley	MS

The government has played an inexorable role in the transformation of the financial services industry in 2007. The regulatory and policymaking team of Bernanke-Paulson-Geithner compelled every major firm, regardless of health, to absorb federal funds on an astonishing scale. Thus, in terms of this study's model, the surviving primary financial institutions would all come to resemble that of an institution in scenario 3: $E(U)_{TARPinstitution} = U[(1-b)\cdot Z\cdot\left(1+\frac{\beta}{\sigma}\right)^{n} - b(vZ)]$, where $\left(1+\frac{\beta}{\sigma}\right)^{n}$ is the "survival utility return given government financing (σ deflates the survival multiplier because a portion of future earnings must be used to repay the government)."[130] The government made its position clearer in the following weeks, when it infused $20 billion more in Citigroup. Paulson and his advisors would not allow the failure of another systemically important firm on their watch. Though it may have shored up the liquidity questions surrounding the crisis, the government policy of credit provision did not address a massive

[130] From Scenario 3—Government as Conduit.

deficiency of high-quality capital on Wall Street and the repercussions deflated the global economy.

3.1

CONCLUSION

The late 2000s financial crisis dramatically altered financial and economic landscapes across the globe. The collapse and ensuing recession depressed the US economy significantly; in the six month period from October 2008 to March 2009, the United States' GDP declined at an annualized rate of 6%. On March 9th, 2009, the DJIA hit 6,547—a ten year low. During this period over 700,000 Americans lost their jobs. Could this economic deflation have been mitigated? The central motivation of this study was to explore systemic risk within the financial industry *during* the subprime crisis and in doing so evaluate governmental policy responses to systemic developments. Faced with a teetering financial industry on the verge of dragging the global economy into ruin, the US government embarked on an ad hoc policy of intervention and nonintervention that shook the banking industry, regulatory environment, and global financial economy.

The implications of my game theory fragility model are stark. First and foremost, I am able to conclude that the aggrandizement of US financial services and banking institutions into six extremely large firms has had significant implications for systemic risk. Prior to the crisis, the US financial system consisted of five major banking conglomerates—JPMorgan Chase, Citigroup,

Wachovia, Wells Fargo, and Bank of America—and five dominant investment banking (shadow) institutions—Goldman Sachs, Merrill Lynch, Lehman Brothers, Bear Stearns, and Morgan Stanley. The forced combination of several of these institutions, along with government insistence that Goldman Sachs and Morgan Stanley reclassify themselves as bank holding companies, has blurred the distinction between the traditional and shadow banking sectors.

The implications of banking industry aggrandizement are unclear. Though the successful combination of fragile firms with healthier institutions was a logical solution prompted by a contagious default crisis, this improvisational aggregation has spawned an imbalanced and unwieldy industry. By the logic of my model (and following the principle of diversification), a financing chain made up of six institutions (though in equilibrium), is much weaker systemically than two separate chains each containing five institutions. A concentration of asset pools and debt obligations in a smaller number of institutions may increase the likelihood that an adverse shock will trigger a systemic collapse. As a factor of their increased size and decrease in numbers, major US financial institutions have become more "systemically important" than ever before. That being said, the probability of a shock adversely affecting an institution (or necessitating capital raising) has been diminished. These firms' immense balance sheets and the diversity of their businesses could serve as insulation from an adverse shock to a specific line of business or asset class. Moreover, diversified asset holdings may prevent the sort of fire sale price depression delineated in the model. Thus,

the repercussions of an aggregated post-crisis industry are ambiguous.

The government's ad hoc intervention policies and their repercussions demand further analysis. The model implies that the government would have better served both the industry and taxpayers by either organizing a rescue or bailout of Lehman Brothers. Wittingly or not, the Bear Stearns rescue signaled to Lehman Brothers—and other institutions—that the government would not sit idly by while major firms teetered on the brink of failure. With the precedent of Bear's rescue in mind, Lehman's management (and the management at other significant Wall Street firms) likely operated during the crisis with some expectation of emergency federal aid. Even on the verge of Lehman's bankruptcy, many Wall Street insiders and analysts rationally expected that it would reach an agreement with the government's help. When the firm went under, "it set off a scramble by corporations and individual investors to get their money out of money-market funds that held Lehman debt."[131] Given Bear's rescue, the market had not rationalized the possibility of Lehman's collapse.

Lehman Brothers' failure was not the outright cause of the crisis, nor would its survival have necessarily prevented the turmoil of October 2008. However, Lehman's failure signaled that the government's "intervention plan had not been fully thought through."[132] Government policymakers never clarified the ramifications of Bear's rescue for future scenarios. When Kendrick Wilson joined

[131] Steve Stecklow (2009): "A Glimpse at Reserve's 'Buck' Race," in *The Wall Street Journal*, January 17, 2009.
[132] John B. Taylor (2009): "The Financial Crisis and Policy Responses: An Empirical Analysis of What Went Wrong," a National Bureau of Economic Research working paper (14631).

Paulson in Washington as an advisor in July, he "asked an official what the Treasury's plan was in case another Bear Stearns developed. The reply came quickly: 'Ken, we don't have a fucking plan.'"[133] This "lack of a predictable framework for intervention,"[134] to borrow John B. Taylor's terminology, introduced unnecessary and harmful unpredictability into decision-making processes for both high-level bank management and institutional investors. Introduction of the TARP facility, which lacked operational oversight and guidelines for use, only contributed to the abounding lack of clarity.

Government interventions and non-interventions "caused, prolonged, and worsened" the ill effects of the crisis.[135] The fly-by-wire nature of Bernanke, Paulson, and Geithner's policymaking undermined the market's rational expectations at nearly every turn. Some observers have argued that today's "largest financial institutions are 'a random collection of survivors.'"[136] What was the rationale for organizing the sale of Bear Stearns and letting Lehman Brothers fail? After the Lehman collapse, when it seemed that the government would not support faltering financial concerns, Paulson bailed out AIG and Citigroup *and* forced nearly every significant institution to accept billions in TARP money. Though the logic behind the government's "mythical experiment of dropping cash

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[133] Lowenstein (2010): *The End of Wall Street.*
[134] Taylor (2009): "The Financial Crisis and Policy Responses: An Empirical Analysis of What Went Wrong."
[135] Taylor (2009): "The Financial Crisis and Policy Responses: An Empirical Analysis of What Went Wrong."
[136] James Freeman (2011): "Mega Banks and the Next Financial Crisis" in *The Wall Street Journal,* March 19, 2011.

from a helicopter in the sky"[137] is in itself dubious, Bernanke amplified the policy's ambiguity by upholding its discretionary property. These officials never announced, clarified, or framed government policy; instead, they *reacted* individually to looming systemic issues with little regard for the confusing and irrational policy program they had unwittingly created.

Within the Hendricks framework, the government mishandled its role in mitigating systemic risk during the crisis. By refusing to aid Lehman Brothers, the government effectively established an unstable industry equilibrium.[138] Due to the existence of self-reinforcing feedback mechanisms, the situation grew worse and eventually necessitated a bailout of AIG (and weeks later Citigroup). Government mismanagement also aggravated Hendricks' systemic characteristics—contagion, hoarding, and flight—by intensifying a liquidity crisis, prompting a credit squeeze, and provoking a flight to safety (in treasury bonds). Furthermore, the crisis also witnessed a bank run, market failure, and pseudo-infrastructure collapse. As sentiment about bank solvency worsened, institutional investors closed accounts, terminated positions, and withdrew vast amounts of money from tainted firms. Due to lax regulation and perverse incentives, credit ratings agencies failed to properly evaluate the creditworthiness of mortgage securities. Finally, though no infrastructure failure occurred *per se,* a lending freeze during the crisis effectively suspended credit provision. Within the context of the Hendricks formulation, the government's errors promoted both

[137] Lowenstein (2010): *The End of Wall Street.*
[138] It is possible that Lehman's management would have taken concrete steps to raise capital and increase liquidity without the rational expectation of government assistance.

rational and irrational systemic instability.

Specific government policies also contributed to the environment that enabled the mortgage bubble and ensuing crisis. During the 2000s, under the leadership of Alan Greenspan and Ben Bernanke, the Fed maintained excessively low interest rates, which stimulated a housing boom. This policy deviated from historical precedent and the Taylor Rule[139], as described by John B. Taylor in his article "The Financial Crisis and Policy Responses: An Empirical Analysis of What Went Wrong." Furthermore, government policies during this period championed home ownership—and surreptitiously contributed to risky loan underwriting practices. GSE expansion and lax mortgage regulations magnified the subprime problem and turbocharged the financial industry's securitization machine. This damning pattern of misguided government fiscal and monetary programs precluded—but undoubtedly shed light on—policy errors that occurred during the mortgage meltdown.

Dodd-Frank and the Upshot

Riding the coattails of a sweeping electoral victory, a newly minted Democratic Congress enacted the Dodd-Frank Wall Street Reform and Consumer Protection Act as a part of President Obama's financial reform platform. According to the Senate Committee on Banking, Housing, and Urban Affairs, this legislation "creates a sound economic foundation to grow jobs, protect

[139] The *Taylor Rule* is John B. Taylor's suggested interest rate policy, which he codified in 1993. It fosters stability and rational expectations by diminishing uncertainty and adhering to historical experience.

consumers, rein in Wall Street and big bonuses, end bailouts and 'Too Big to Fail,' and prevent another financial crisis."[140] Though the bill's specifications sated the public's moral revulsion against Wall Street 'excess,' their vagueness blunted its regulatory power. The overtly political discourse surrounding the act and calculated ambiguity of the bill's provisions fail to address several of the crisis' most salient consequences.

Though ambitious in scope, Dodd-Frank has introduced unnecessary layers of complexity in the financial system. It claims to end the concept of 'Too Big to Fail,' but stipulates that the government may still provide emergency loans to teetering firms, provided that similar borrowing terms are offered to other institutions. Under the act, the FDIC may also employ its 'orderly liquidation' provision to seize control of 'systemically important' firms, without shareholder or management consent. The bill does not delineate any systematic description of creditor hierarchy or asset distribution for this liquidation process, which may drive "creditors and trading counterparties [to] flee even faster than they would from a firm headed toward bankruptcy."[141] Moreover, the bill does not provide guidelines for the determination of 'systemically important' firms eligible for federal funds. This undermines its stability goal and reintroduces the "atmosphere of unpredictability"[142] that characterized September and October

[140] United States Senate (2010): "Brief Summary of the Dodd-Frank Wall Street Reform and Consumer Protection Act." http://banking.senate.gov/public/_files/070110_Dodd_Frank_Wall_Street_Reform_comprehensive_summary_Final.pdf. Accessed March 2, 2011.
[141] Freeman (2011): "Mega Banks and the Next Financial Crisis."
[142] Freeman (2011): "Mega Banks and the Next Financial Crisis."

2008. The ambiguity of Dodd-Frank financial reform has increased uncertainty and added new wrinkles to the conception of systemic risk.

The legislation's incredibly convoluted and highly ambiguous language illustrates the government's inability to pragmatically and nonpolitically address financial reform. The Senate Committee on Banking, Housing, and Urban Affairs' explanation of its plan to reform the Fed's lending practices reveals this obscurity:

> "[This legislation] limits the Federal Reserve's emergency lending authority by prohibiting emergency lending to an individual entity. Secretary of the Treasury must approve any lending program, programs must be broad based, and loans cannot be made to insolvent firms. Collateral must be sufficient to protect taxpayers from losses."[143]

This stipulation does not effectively limit the Fed's lending authority; by expanding the scope of any future intervention, it upholds the 'forced-loan' precedent established by TARP. Though 'broad based' lending, as proposed here, diversifies taxpayer risk, it encourages massive balance sheet liabilities on the government's behalf and precludes careful risk calculation. In addition, one would never expect the Fed to inject cash into an *insolvent* (read: failed) institution, it would most likely provide financing to an institution facing the prospect of *illiquidity*, which often precedes insolvency. Finally, this statement runs counter to the FDIC's newly minted seizure capability and mandate to orderly liquidate failing institutions.

It is my recommendation that the government would be better served by

[143] United States Senate (2010): "Brief Summary of the Dodd-Frank Wall Street Reform and Consumer Protection Act."

implementing several specific regulations. First, the Treasury, Federal Reserve, FDIC, and SEC must cooperate to impose a two-pronged standard of strict capital requirements and financial statement transparency, including mark-to-market derivatives positions and disclosure of subsidiary holdings, on the financial sector. This policy would mandate appropriate degrees of leverage industry-wide and facilitate counterparty risk evaluation. Furthermore, the government must construct an "exceptional access framework"[144] to create a predictable, nonpartisan process for future interventions. This must include a constantly updated risk evaluation of 'systemically important' institutions that is available to the public. I suggest a modified combination of the Dodd-Frank Act's Financial Stability Oversight Council and Office of Financial Research to oversee the industry and assemble regular risk evaluation reports. During a crisis, this oversight bureau must clearly state a diagnosis of problems and its rationale for interventions.[145] These relatively straightforward measures, combined with provisions for consumer and investor protection, mortgage and lending reform, and increased derivatives oversight, could theoretically mitigate systemic risk in the financial system in the future.

[144] Taylor (2009): "The Financial Crisis and Policy Responses: An Empirical Analysis of What Went Wrong."
[145] Taylor (2009): "The Financial Crisis and Policy Responses: An Empirical Analysis of What Went Wrong."

APPENDIX A

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