Engineering Financial Safety: A System-Theoretic Case Study from the Financial Crisis

by

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B.S. Economics, Wellesley College, 2005

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Abstract

There is currently much systems-based thinking going into understanding safety in complex socio-technical systems and in developing useful accident analysis methods. However, when it comes to complex systems without clear physical components, the techniques for understanding accidents are antiquated and ineffective. This thesis uses a promising new engineering-based accident analysis methodology, CAST (Casual Analysis using STAMP, or Systems Theoretic Accident Models and Processes) to understand an aspect of the financial crisis of 2007-2008.

This thesis demonstrates how CAST can be used to understand the context and control problems that led to the collapse and rapid acquisition of the investment bank Bear Stearns in March 2008. It seeks to illustrate the technological and regulatory change that provided the context for the Bear Stearns accidents and then demonstrates how a top-down systematic method of analysis can produce more insight into the accident than traditional financial accident investigations such as congressionally-mandated inquiries.

Thesis Supervisor: Nancy G Leveson
Title: Professor of Aeronautics and Astronautics and Engineering Systems

Acknowledgments

I would like to thank Professor Nancy Leveson for supporting this somewhat unorthodox thesis and for the fundamental shift in world view that her tutelage has brought me: I will never look at safety or complex systems in the same way again. My colleagues in the Complex System Research Laboratory have also provided invaluable insights, discussions, and chocolate just when I need them most, and have made this process immeasurably more pleasant. I look forward to hearing how all of you are changing the world and making it a safer place in years to come.

To my parents-despite putting all your eggs in one basket, you finally managed to get to be the parents of an MIT alumna. Thank you for being the best role models any student could ask for. To the Law Reading Group-thanks for all the venting and coffee sessions, they were beyond invaluable. To Raj-thank you for cheerfully volunteering to work late so often so that I could get my schoolwork done, and thank you for teaching me the MIT fight song.

And for the sake of giving thanks where they are due, I cannot leave out the Twinning Tea Company, for the tea over which I did all my best thinking, and the C + C Music Factory, for creating *Everybody Dance Now*, which revived a waning spirit at precisely the right time.

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Chapter 1 Background

"To use a metaphor, yes, there is a general interest in how the fire was brought under control, but our job is to find out why the fire started; what warning signs were ignored; what building codes, if you will, could have prevented the fire in the first place; where were the firefighters; who was playing with matches."

-Phil Angelides,
Chairman of the Financial Crisis Inquiry Committee
Discussing the rationale for investigating the collapse of Bear Stearns

1.1 Motivation and Approach

The financial crisis that began in 2007 is one of the most perplexing and important modern events, and as such does not suffer from a lack of analysis. Because the events, people, and causes of the crisis have been discussed, dissected and dispersed throughout media and academic circles in the years since 2007, any new insights will be rare. However, this does not mean that there is no value in exploring new analysis methodologies, especially ones that seek a more scientific objectivity than traditional methods-indeed; it is precisely because of the highly subjective nature of most existing analysis that I am writing this thesis.

Having worked in the financial sector as a technology consultant for the four years surrounding the crisis, I saw first-hand how many workers in the industry were genuinely perplexed by how quickly the crisis unfolded, and with such great magnitude. However, the popular analysis of the crisis at the time and in the time since is-not surprisingly-highly subjective. Various commentators arrive at various conclusions that are largely dependent on their personal perspective and experience. When, during the course of my graduate studies, I became exposed to modern accident analysis

techniques that attempt a top-down systemic approach to understanding large physical accidents, I immediately began to wonder if these techniques could be applied to a non-physical system like the financial sector.

This thesis attempts to do just that-demonstrate how the application of a system engineering approach to accident analysis can provide an objective methodology for accident investigation, even in a non-physical system. I believe that the use of system theoretic tools when considering any sort of organizational question-physical or nonphysical-can be massively beneficial. This thesis will take one small aspect of the financial crisis-the government bailout of the investment bank Bear Stearns in 2008-and treat it like an engineering accident. It will systematically seek to understand how organizational factors and inadequate control mechanisms contributed to the bailout. My goal, however, is not to come up with new and novel observations or recommendations (given such a high profile "accident," it is safe to say that the myriad of existing commentary has addressed almost any major point) but to demonstrate a new and novel approach to understanding how non-physical techno-social systems are engineered. While this thesis looks back at an accident that has already occurred, the system-theoretic principles can also be used to look forward in designing safer financial systems. Because this analysis seeks to examine a small piece of the crisis timeline as if it were an engineering accident, there will be no bad guys or good guys in the story, but only incomplete system designs and inaccurate mental models.

I chose the Bear Stearns case for many reasons. It was one of the first major "accidents" of the financial crisis, and had an unprecedented federal response that many believe led to ever-growing federal bailouts. My primary reason for choosing this as a case study, however, came from reading the testimony of Bear Stearns executives given to the Financial Crisis Inquiry Commission (FCIC) as part of their examination into the crisis as a whole. In their testimony, all of the executives likened what happened to Bear Stearns to "an act of God," something that they could not be expected to anticipate or guard against. The idea that a system that is entirely created, implemented, and operated by human beings could suffer from the whims of a higher power and that that might be used as an excuse to not proactively

analyze, understand and *change* the system in a constructive way seems the height of dangerous close-mindedness to me. Thus, I determined that a systems-based analysis of the events of March 2008 might shed some light on ways to understand our social systems without shrugging accidents off as the acts of a higher power.

This is not a thesis about how the financial system works, but about a systemic way to evaluate an accident within the financial system. However, an understanding of the financial sector, especially the rapid technological change and deregulation that occurred in the half century leading up to the crisis will greatly inform the analysis. Additionally, background information on the history of the firm in question-Bear Stearns-will also increase the quality of the ultimate analysis. Therefore, the analysis proceeds as follows: this chapter examines some of the existing academic inquiries of interest, both in the system safety/accident analysis realm and the financial regulation realm. It surveys some of the existing accident analysis techniques and methodologies and focuses especially on the accident analysis method used in this thesis. Secondly, it examines relevant literature about the motivation for financial regulation and the crisis itself. Because doing a comprehensive review of this material would be beyond the scope of this analysis, I focus on some key work that addresses issues relevant to performing an accident analysis on a social system, as well as the few pieces of existing research that explicitly consider parallels between engineering safety and financial system safety.

Chapter Two examines pertinent details of the technologic and regulatory changes occurring in the financial sector in the half century leading up to the accident. Chapter Three lays out a brief history of Bear Stearns and the events leading up to the March 2008 government bailout. Chapter Four applies the new accident analysis technique-CAST-to the accident. Finally, Chapter Five briefly compares the results of CAST with the congressional investigation of the financial crisis (the closest thing to an official "accident report" that exists) and discusses recommendations and future work.

1.2 Review of System Safety and Accident Analysis Techniques

Accident analysis methods generally rest on a specific theory of how accidents occur, and much of the literature on accidents analysis and system safety seeks to describe accident models generically. Because the majority of the early methods center around the goal of determining accident causality, it can be inferred that many of these models tacitly believe that any given accident has a very specific root cause that, if understood before the accident, might have been engineered away.

The earliest documented accident models were chain-of-events models that conceive of accidents as the result of a linear chain of events and seek to determine and eliminate the proximal events leading to the accident [14]. This idea of a specific chain of events as the necessary condition for an accident, illustrated in 1-1, was retooled in later years to the "swiss-cheese" model, a model that models accidents as occurring when different "holes" in various defenses of an organization align to create a gap in safety and cause an accident-leading to a belief that safety can be assured given appropriate "defense in depth" precautions, that is, adding enough layers to avoid the holes ever lining up [31]. Most modern accident analyses involve some sort of proximal event chain and discussion of the specific "events" that led to an accident.

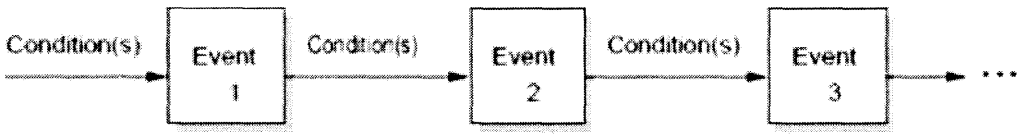

Figure 1-1: A Simple representation of a cause and event chain, from Leveson 2012

Many objections have arisen from system thinkers about the efficacy of this sort of cause-and-effect analysis. Rasmussen argues that true safety within a dynamic system calls for "functional abstraction rather than structural decomposition" and should focus on "a model of behavior shaping mechanisms" [30]). These mechanisms would include "work system constraints, boundaries of acceptable performance, and subjective criteria guiding adaption to change" [30]. Leveson continues the argument for

system-theoretic safety models that robustly capture all of the factors-both mechanical and organizational-that may lead to future accidents. She asserts that a technique based on systems theory is the sounder option [19, 20]. A systems approach to safety will do many things, including provide a top-down approach; focus on the system as a whole with attention to the relationships between technical, organizational and social aspects; and help develop ways to model and design safety structures instead of trying to come up with general principles [20]. Using a systems approach to analyze accidents means that instead of relying on the analyst to "correctly" lay out the chain of cause and effect events to understand an accident, the analysis will follow a more systemic approach that focuses on the control and feedback mechanisms of the system in which the accident occurred. The "system" in this case is not only the mechanical or human components but includes all of the organizational and contextual (such as the regulatory structure) elements of complex socio-technical systems.

The question of how organizational factors[1] influence the incidence of accidents is also an important question in system safety theory. Leveson (2009) describes two schools of thought: one school of thought holds that there are "Normal Accidents," that is accidents that are inevitable or normal due to the complex, tightly coupled nature of modern systems. Another theory holds that accidents can be mitigated by organizational structure and that there exist certain Highly Reliable Organizations (HROs). HROs are able to avoid accidents despite very difficult industrial problems or requirements and some believe that studying the methods these organizations employ can be a clue to designing safer systems in general. Leveson points out that a fundamental problem with many of the previous approaches to understanding accidents is the tendency to confuse safety with reliability[20]. Safety, she argues, is an emergent property of the system; while reliability is a characteristic of individual components (i.e. does a specific part of the system perform to its specification?). In engineering, a focus on component reliability means that a complex system is determined to be safe as long as all of its various components meet some minimal reliability thresholds. As long as we can expect components to fail infrequently, this

[1]Such as the structure and makeup of a firm, how it deals with safety concerns, and similar issues.

school of thought concludes that the system will be adequately safe. However, as Leveson points out, concern with only component reliability ignores many important interaction problems and will overlook many safety issues. The system-theoretic view of safety conceptualizes the safety of a system as a control problem-that is, a system is safe if the appropriate safety constraints keep the system from migrating into an unsafe state.[2]

If safety is viewed as a control problem, then "accidents occur when component failures, external disturbances, and/or dysfunctional interactions among system components are not adequately controlled or handled" [20]. Safety as a control problem means that to analyze system safety, we need to start to think about control issues-the control structure and mental models of operators. All organizations have safety control structures, an example of which is depicted in 1-2. This figure displays a general control structure of a socio-technical system. This splits the system into both operational and development sides (or strategic and tactical) and shows how the two interact with each other as well as how the various levels within the system interact hierarchically.

An often discussed type of modern accident involves issues with component interaction in these socio-technical systems. As systems are increasingly dependent on software components, the question of how to ensure that software is "safe" has become one of concern to many engineers and operators. Leveson has described the systems-theoretic approach to safety as an answer to the question of software safety, treating safety not as the result of component reliability, but instead as an emergent property of the system itself [20]. The emergent nature of safety under Leveson's framework relies on the idea that different safety constraints can be applied to a system at different hierarchical levels within that system-if the constraints hold within the various levels, then a safe system state will result. This model of accident causation is called STAMP (Systems Theoretic Accident Model and Processes). From this model, Leveson developed an accident analysis method called CAST (Casual

[2]For example, a typical train may have the safety constraint that the door cannot close if there is a person in the doorway. This constrains the behavior of the door-it cannot close in this situation, even if other conditions that would normally cause it to be closed, such as time to depart, are met.

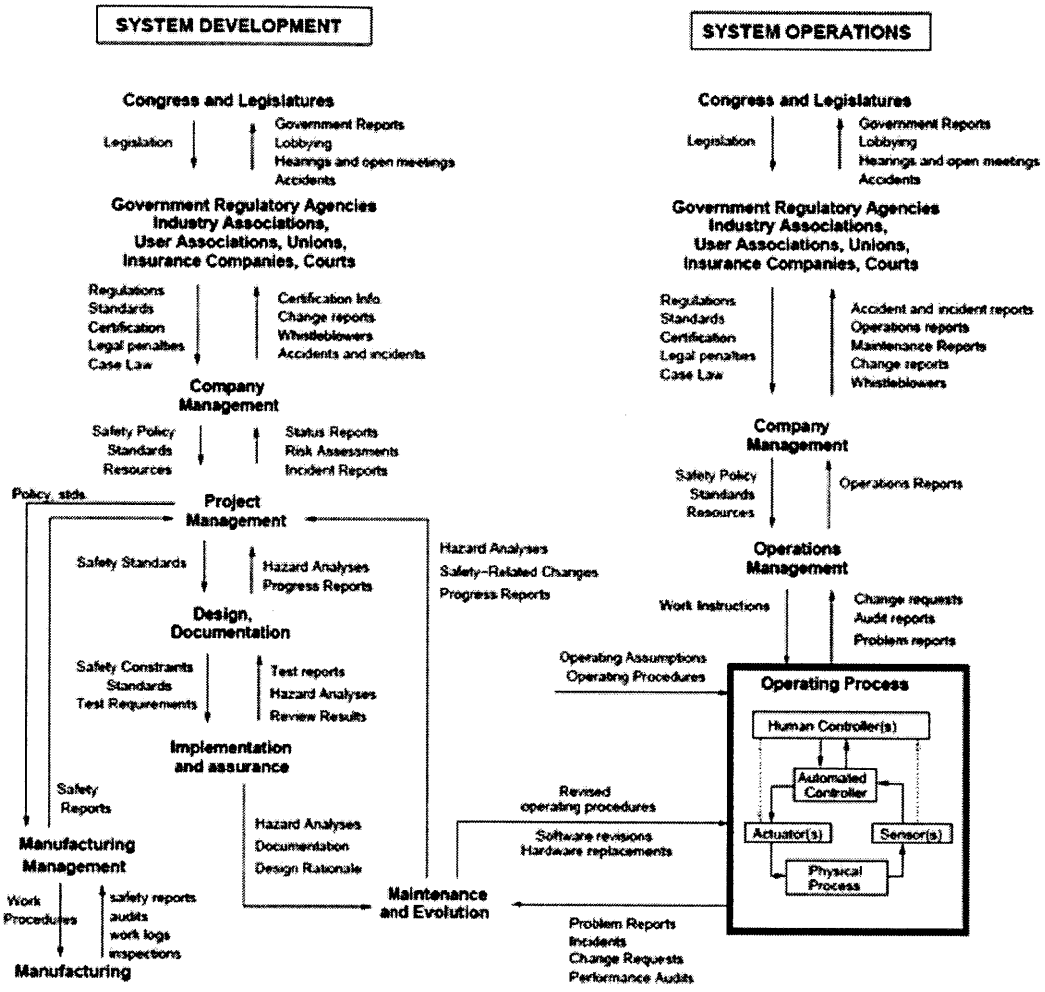

Figure 1-2: Leveson's model of the control structure of a general socio-technical system.

Analysis using STAMP) that analyzes an accident for hazards introduced during the system design process [19]. CAST is an accident analysis method that attempts to systemically examine an accident and identify design changes and recommendations that might have prevented the accident.

The astute system safety reader will undoubtedly be wondering about the usefulness of applying a method like CAST to a socially designed (as opposed to physically designed) system like an investment bank. While CAST was designed to be applied to physically engineered systems (existing applications of the method include aircraft accidents, oil refinery accidents, rail accidents and others) there is nothing inherent to the analysis process that precludes it from being applied to social systems. It is certainly the case that there are a number of important distinctions that will differentiate this analysis from previous applications, but none of those distinctions reduce the potential usefulness of a more scientific analysis of social accidents. Indeed, when we remember Leveson's description of CAST, it seems ideally suited for application in fields beyond typical engineering and system safety:

> The use of CAST does not lead to identifying single casual factors or variables. Instead it provides the ability to examine the entire sociotechnical system design to identify the weaknesses in the existing safety control structure and to identify changes that will not simply eliminate symptoms but potentially all the casual factors, including the system ones. [19]

A central motivation behind a systems approach is to avoid trying to resolve problems by identifying a "scapegoat." When we allow that many accidents happen because people make decisions that they think best at the time they have to make them given the information they have at hand, we can see that the problem generally is not that the people are bad, but it may be that the system is designed in a way that an operator does not have all the information they need or perhaps thinks that the state of the system is different than it is [19]. This distinction is important when considering the safety of the financial system and how best to regulate it. The following section presents some of the leading academic theory on how and why we

have financial regulation, while Chapter 2 discusses the details of our regulatory system.

1.3 Review of the Principles of Financial Regulation

A wide variety of academic papers have been published in the years since the crisis began that are focused on regulations and how regulatory forces (or the lack thereof) contributed to the crisis of 2007-2008. Much of the literature focuses on the causes of the crisis, with general meta-causes (e.g. poorly valued MBSs, a panic-induced credit crunch, the difficulties of pricing certain types of assets, an over-issuing of CDOs) often agreed upon but concrete plans for regulatory change much harder to demonstrate with any sort of rigor. However, many of these theories offer valuable insights into the workings of the financial system as well as hypotheses that are especially interesting when viewed through the lens of the accident models discussed above. This section will highlight existing literature on the roots and the impact of regulatory schemas on the financial crisis and the intersection of system engineering and financial engineering.

1.3.1 United States Financial Regulation

Because financial regulation is a primary focus of this analysis, it is important to distinguish up front between the regulatory and supervisory duties of various federal agencies. Financial *regulation* refers to the rules and regulations set forth by governmental bodies that dictate how markets and the firms within their jurisdiction can legally operate. Additionally, the governmental agencies may take on *supervisory* roles within a market such as monitoring *how* an institution conducts business (which may be determined, in part, by regulations). The primary focus of this thesis is on the regulatory and policy-oriented role, not the supervisory role, of the federal government in the financial sector.

While specific details of the financial regulatory history of the United States appears in Chapter 2, this section discusses the more theoretical regulatory theories

of US financial regulation and the events of 2007-2008, as well as academic theories on how to engineer a better regulatory system. While there is a general pessimism that any sort of ideal or flawless regulatory scheme for the financial industry will ever exist, several researchers have identified common pitfalls in financial regulation and general ideas for reform.

A common assumption when considering a financial regulator apparatus is the idea that no degree of regulation can completely eradicate financial crises. Many financial academics posit that periods of financial turmoil may be an "unavoidable aspect of modern capitalism [...] a consequence of the interactions between hardwired human behavior and the unfettered ability to innovate, compete, and evolve" [21].[3] However impossible he believes it may be to avoid financial crisis, Lo argues that an effective regulatory scheme will ensure that risks are born and realized by the appropriate parties-specifically those who knowingly choose to engage in risky investments and have all the information necessary to make risky decisions. Lo continues by claiming that besides allocating risk fairly, financial regulation should strive to facilitate access to information and education and to address market failures and human behavior.

A common observation in financial theory is that throughout history the financial system has been plagued by "a series of conflicting incentives for those participating in and regulating the financial field" [29]. In other words, "greed" is an inherent part of the system and cannot be regulated away. The nature of personal gain versus public welfare is an important dynamic when considering a system as complex as our modern financial system. The question of how we can define and construct a "safe" financial system must take into account the conflicts inherent in such a system-if I am going to get rich, does that mean that someone else must become poorer? Is the financial sector a zero-sum game?

Another important academic (and practical) question is what the theoretical underpinnings of a revised regulatory schema would look like. A blueprint published

[3]It is interesting to note that Lo and many other financial academics often cite Perrow's theory of Normal Accidents (a theory discussed in the System Safety area as well) when discussing the financial sector and how to regulate it. The distinction between acceptable or normal disruptions or accidents in finance is important to keep in mind throughout this analysis.

by the US Treasury in 2008 details the four broad patterns a revamped regulatory regime might follow: the continuation of our current functional regulation based on broad industry segments, a functional regulation that focus instead on the activities of firms, a single regulator for all financial services (similar to the UK), or a shift to an objectives-based regulatory system that focuses on specific regulatory goals [28]. The current functional segment-based regulation manages industry segments (e.g. securities issuers, investment advisors, insurance companies, mortgage lenders) by different regulators, despite the fact that often a single firm participates in several of these segments. An objectives-based system would create separate regulators for various broad objectives (e.g. market stability, safety and soundness, business conduct) and the ability to regulate across industry segments to achieve the market objectives.

While there is a fair amount of theoretical literature on financial regulation, there is a relative dearth of literature that qualitatively examines relative regulatory schemes. As Jackson points out, there are "considerable difficulties conducting a theoretically complete analysis of the costs and benefits of financial regulation, as well as problems associated with making international comparisons between observed levels of the intensity of financial regulation" [15]. Jackson attempts to measure the relative intensity of financial regulation in a range of industrialized nations measured by budget and staffing costs and shows that there is a wide variation between seemingly similar nations, with the United States generally having much more regulation than other countries. He concludes that this could be because the nations have different desired regulatory outcomes, because some countries are much more efficient in their regulation than their counterparts, or a combination of the two effects [15].

Executive Compensation

A popular issue in the discussion of the Financial Crisis is that of the contribution that Wall Street compensation practices made to create a hazardous state for the financial system. The theoretical idea is that if compensation is tied directly to performance, then executives and traders on Wall Street are incentivized to make smart trades and not take undo risks. After the government-backed bailout of Bear

Stearns in 2008 (detailed in Chapter 3), many in the media questioned whether or not there was now an opportunity for moral hazard: that is, if bankers expected a government-bailout for all bad bets, but were allowed to keep profits on good bets, would they be unduly risky? The question of just how much wealth bankers lost in the financial crisis was examined by Bebchuk, Cohen and Spamann, who found that while the crisis did wipe out some of the value of stock held by top executives during the crisis, none of these executives were "financially devastated" and all of the net payoffs to executives during the 2000-2008 years "were decidedly positive" [1]. Other research looking at how the degree to which executive compensation incentives were aligned with shareholder incentives found little evidence that tying CEO compensation to stock price had an effect on how a firm weathered the financial crisis, nothing that "CEOs who took exposures that performed poorly during the crisis did so because they thought that doing so was good for shareholders as well as for themselves" [7].

Complexity and Systemic Risk

A major goal of post-crisis financial regulation is the reduction of systemic risk. System risk in the financial sector is generally understood to be the idea that the entire system might be in jeopardy with the failure of a single component or institution.[4] Put simply, that the risk is coming from the financial system itself-from its structure and composition-rather than from known, calculable risk profiles. Financial theory holds that systemic risk may occur due to market imperfections or externalities that are particular to the financial sector: the reliance on rumor and speculation inherent to finance can cause difficulties at one institution to be perceived to exist at other institutions, those facing difficulties due to one institution's failure may be unable to easily send their business to another institution, and the more obvious factor of the modern financial system's inherent inter-connectedness and susceptibility to liquidity-asset price spirals (see Chapter 2 for more information on liquidity-asset price spirals)

[4]An alternate definition holds that a single external shock can disrupt the entire financial system; this definition is less interesting to consider from an analysis perspective, however, because there will always be an even greater external disaster-a meteor hits Wall Street-that *could* occur, and a regulatory system need not account for every possible "act of nature" to be well designed.

[3].

One of the main tools that modern financial regulators have used to address system risk is capital requirements-the amount of available capital that a firm must have on hand relative to its deposits. This strategy tacitly supports the belief that the system can be made safe if the individual banks within it are all safe [2]-which is a view that is dangerously reminiscent of the aforementioned system safety paradigm that any system can be certified as "safe" as long as its component parts are all reliable.

Most financial researchers agree that systemic risk is a direct result of increasing complexity within the financial sector and must be acknowledged and accounted for in any modern regulatory system that is going to be effective. Lo writes: "a critical unintended consequence of the financial innovations of the last two decades is that regulators now see and control a much smaller fraction of the financial system than before, and the controls at their disposal are no match for the more adaptive strategies employed by private financial institutions" [22]. Lo describes some of the network-theory based attempts to model the complexity of the financial sector in an effort to produce more effective regulatory tools. For the most part, these complexity-based regulator recommendations involve more complex regulations, such as "time varying macroprudential policies that adapt countercyclically to business and credit cycles" [22]. While it may seem somewhat counter-intuitive to solve the problem of a complex financial sector with more complex regulatory practices, Lo and colleagues draw a distinction between the organization of the regulatory bodies and the mechanics by which they set their policies.

Financial Safety and Engineering

The idea of applying engineering techniques to the financial sector (as this thesis attempts) is not a novel one; the application of scientific principles has some history in the financial realm and in the policy realm. The most direct evidence of the crossover from science to finance is the growing prevalence of engineering majors using their quantitative backgrounds to design and create complex financial instruments. Thinking about policy in a system-theoretic way has been examined by political

scientist Laurent Dobuzinskis, who argued that applying control theory to the policy process can confuse the issue of just what exactly control means:

> From the standpoint of engineering, there exists a significant difference between 'control' and 'regulation.' The former refers to the operations of an identifiable controlling device which is not part of the structure it controls (e.g., a thermostat monitoring the temperature of a gas or fluid). The later, often described as 'dynamic regulation,' applies to a range of interactions internal to a system and by means of which that systems manages to reach certain goal states. [6]

Dobuzinskis argues for alternate conceptual understandings of public policy, but allows that the control-theory view of policy, where regulation is a constraint imposed on a complex system, does have its conceptual usefulness. He goes on to remind analysts that "individuals and extraordinary events almost always influence the outcome of a policy" [6]. However, the application of STAMP, a system-theoretic model that did not exist when Dobuzinskis was examining the use of such models in the policy-process, addresses the concerns raised by acknowledging that safety is an emergent process and that all of the assumptions made by various control loops must be examined individually [19]. Also STAMP includes the concept of controls that are designed into or an inherent part of the system components and not a separate controller.

This concept of scientifically engineering safety into the financial system just as it is engineered into other complex physical systems has received some academic attention, particularly in the years following the financial crisis of 2007-2008. Fielding, Lo, and Yang describe how the National Transportation Safety Board, an independent federal agency tasked with investigating major transportation accidents and producing regulatory recommendations, could be used as a model for organizations tasked with addressing systemic risk in other industries, especially finance [11]. This novel idea would involve some necessary assumptions for the financial world, assumptions that will also be relevant to this thesis. For instance, the authors agree that "financial loss is indeed a necessary and unavoidable corollary of risk, financial innovation,

and economic growth" but argue that treating financial "systemic events" in the same manner that other industries treat major accidents could improve the system tremendously. The authors also make the observation that while financial accidents may not result in a direct loss of life (as transportation and other industry accidents might) the sheer cost involved is non-trivial from a public welfare perspective. If traditional statistical value of life measurements are applied (as they are to weigh the costs and benefits of many policy decisions), the $50 billion spent on the Troubled Asset Relief Program equates to more than 7000 lives lost [11].

Attempting to extend this idea that financial safety can be treated in the same manner as other forms of safety is the primary goal of this thesis. The same motivation that led Fielding et al to consider the NTSB as a model for analyzing systemic events in the finance sector is a natural lead-in to the hypothesis of this thesis, that a specific system-theoretic methodology for accident analysis can successfully be applied to a non-physical complex system such as the financial sector.

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Chapter 2 A Technological and Regulatory Exploration of Finance

"Though the principles of the banking trade may appear somewhat abstruse, the practice is capable of being reduced to strict rules. To depart upon any occasion from those rules, in consequence of some flattering speculation of extraordinary gain, is almost always extremely dangerous, and frequently fatal to the banking company which attempts it."

-Adam Smith, The Wealth of Nations, 1776

The financial crisis that began in 2008 has been blamed on a complex array of possible causes: new financial products so complex that even their issuers didn't fully understand them, low interest rate policy resulting in a residential housing bubble, conflicting incentives on Wall Street and Main Street and Capitol Hill. In order to place the financial crisis and the Bear Stearns accident in appropriate context for a CAST analysis, this chapter looks back at the history of the financial industry in America and the technological and regulatory changes that led up to the events of 2008. Instead of providing a chronological narrative of events in the history of finance—which can certainly be found in a number of other places—this chapter explores two of the areas that most directly impact the safety and stability of the financial sector: technological and regulatory changes in finance. The first part of the chapter focuses on technological change. The second part of the chapter looks at the historical details of three broad segments of the industry with these technological changes in mind: commercial and investment banking, "shadow banking," and securitization.

2.1 Technology

Because all financial markets operate to redistribute or generate[1] capital, and because common forms of capital—such as US dollars—are proxy instruments used to evaluate the relative value of goods and services, the financial sector can be said to fundamentally be an information sector. When seen this way, it becomes clear how technologies that work to accumulate, validate, and disseminate information have had drastic impact on the financial sector.

Technological developments[2] first began to radically influence finance in the mid to late nineteenth century, with the effect, as Lo describes it, of "mak[ing] time shrink" [23]. These technologies were the telegraph (invented in 1844 and coupled with the first transatlantic cable, linking New York and London in 1866), the stock ticker (1867) and the telephone (1876). While the first two are now relics of the past (and the later has morphed into an arguably different technology all together in the last century and a half), these technological advances were the first steps to a new financial sector. Where it had once taken days for information to travel great distances, it could now happen almost instantaneously. The introduction of these information dissemination technologies meant that the buying and selling of stocks and bonds was no longer a highly localized economic activity, but one that could span continents. While these three technologies were not explicitly invented with the financial sector in mind, they were all very quickly picked up by market participants, demonstrating that an information edge translated into a distinct financial advantage in the market environment.

This effect of "time shrinking" had many important implications for the direction and pace of financial markets, especially evolving the definition of "normal," both in terms of the daily volume of market activity and the quantity of necessary informa-

[1]The philosophical and practical differences between the goals of redistribution and generation should be carefully considered, but as this is not a philosophical thesis, I will leave this consideration to the reader.

[2]Technology here describes those external technological developments that significantly impacted the financial sector, regardless of whether or not they were developed with financial application in mind. The evolution of specific types of financial technology (a term occasionally used to describe specific new and novel financial instruments) is discussed in the section on Securitization.

tion needed to be an intelligent investor. With the establishment of the Dow Jones Industrial average in 1896, numbers and data began to be regarded as an invaluable tool for anyone hoping to make money in the financial sector. The NYSE originally began to provide market statistics (such as monthly indexes and averages) in an effort to promote optimism and market confidence after the crash of 1929, but these statistics quickly became part of the necessary toolkit for a new type of "technical analyst"—those who believed that the markets could be decoded and money could be easily made given the informed and intelligent analysis of this market data [23].

The mid twentieth century experienced this paradigm shift in how the basic tools of stock market analysis—various trends, patterns, and cyclical behavior—could be used to predict future behavior. The sudden abundance of available data meant that there was data to analyze, and the view that markets followed rules and patterns of behavior that could be scientifically studied began to take hold. This meant as well that the field of economics gained momentum and prestige as an academic and scientific school of thought, instead of something that was only of interest to business and corporate types looking to read a balance sheet. There was, during the twentieth century, a "move from [a] predominantly descriptive and institutional approach to the academic study of finance to the analytical, economic, and increasingly mathematical viewpoint" [24]. The changes in the perception of economics and financial study as a scientific field were coupled with the practical changes that technology afforded. Structured investment vehicles such as mutual and index funds became more widespread. Day trading for small investors became feasible. The market becomes more global, and suddenly the strength of the dollar and relative interest rates become more important than ever before. By June of 1975 a system that displayed all trades as soon as they are executed, called "consolidated tape," allowed investors to see what is going on real-time in both big and small exchanges and continued the march toward a data-driven financial sector [23].

Of course, the biggest change to come on the financial scene was the introduction of the computer and the revolutionary analytical, computational, and communicative abilities that it brought with it. The widespread use of computers can easily be

said to have changed nearly every aspect of the financial sector. Even things as mundane as the format in which stock prices were quoted was forced to adapt: in the new era of big volume trading, the fractional prices previously used were not precise enough, and market makers were eventually forced to use decimals in order to keep spreads precise [23]. But even beyond practical technical adaptations such as the decimal point, the feeling at the time was that the impact of computer networks on the financial sector and its employees had been and would continue to be immense. Barron's wrote as early as 1965 that "the potential rewards of the computer, properly used, promise to be immeasurable" and that the immense calculation power provided by these machines would "relieve an analyst of all such dreary labor, freeing him for more creative activity" [23].

The freedom from "dreary labor" provided by mechanical and electrical computers cannot be overstated. Nordhaus describes the major developments in computing—from mechanical calculators and punch-card technology in the late 1800s to microprocessors in the 1970s to personal computers in the 1980s and calculates that the increase in computational capacity gained between 1940 and 2000 alone is analogous to a 55% annual growth rate [27]. If we consider that financial analysis is based almost entirely on mathematical computations, the effect of this drastic increase in computational power on the financial sector becomes obvious.

Lo's "creative activity" made available to finance analyst now free of the drudgery of banal calculations led to many new types of institution and strategy. Quantitative trading—where computers analyzed vast troves of data to look for any predictable market movements—become popular in the 1990s. Electronic Communication Networks—markets where the buyers and sellers are matched directly, eliminating the middle man or market maker, and thus enjoy lower commissions, faster execution and convenience—also saw rising popularity in that era. Bloomberg brought all of the speed and analytic power to the financial masses with the introduction of "Bloomberg terminals" and set the standards for computerization in the industry. All of the changes brought on by computers would be much less impactful, though, if it were not for the introduction of computer networks and communication protocols

such as the Internet.

Because the Internet is, at heart, a mechanism for information storage and dissemination, it goes without saying that its potential impact on the financial sector, an information marketplace, is huge. Wilhelm proposes a model of the financial market that has seen an evolution in human capital roles as the internet has expanded. In this model, financial intermediaries are people who have historically had both information origination and dissemination roles—for example, a syndicate manager will apply human capital to both create and to sell a new corporate bond—but information technologies are increasingly enabling the dissemination duties to be automated. Wilhelm argues that as a result the role of human capital in the financial system has evolved to something closer to "independent content providers"—that is, traders might be employed by major institutions, but their intellectual product is somewhat "unbundled" from the pipe through which it enters the marketplace, giving financial workers an unprecedented new power, responsibility and mobility within the financial sector [35]. This mobility within the sector is especially important when considering an employee's incentives for remaining in the employ of a particular firm—how a banker's relationship with the bank that employs him or her changes when that banker becomes an "independent content provider."

The practical impact of changing technologies on the financial sector is a factor often mentioned in discussions of the crisis. In the opening testimony of the Financial Crisis Inquiry Commission's (FCIC) hearings related to the Bear Stearns collapse, the chairman of the commission used changes in the automobile industry over the same time period (the 1970s-1990s) as a yardstick for the financial industry. He commented that where once it had been entirely possible for backyard mechanics to effectively tinker with—and understand—the workings of early cars, by the 1990s most cars had such complicated electronic systems that they had to be taken to a dealer with "expensive diagnostic machinery." The chairman then connects the automobile industry with the financial industry:

> What we are beginning to find out is that the financial markets got just

> as complicated, because people wanted specific products for specific purposes. And the old established structure was not, either because of regulations, or historical patterns, convenient or appropriate [9].

This idea of "specific products for specific purposes" is an important one to consider in the technological context. (See Appendix A – Financial Products and Definitions for definitions of a few "specific products" such as CDOs and MBSs that the Chairman may have been referring to.) Many people refer to these products as "financial innovations" and are referring to them when they discuss "financial engineering." Many of these products owe their existence to the increased computational power of computers and the increased communication power of the Internet—tools that enabled the creation and explicit tailoring to "specific purposes" of these products. More details on the history of securitization can be found later in this chapter, the remainder of which explores some of the regulations and historical patterns the Chairman referred to above.

2.2 Regulation

Financial regulation is a complicated subject, influenced by politics, economics, and preferences. In general, any sort of federal regulation exists in an attempt to correct a perceived externality that the market alone cannot address. The proverbial example is that of the common good—when there is a "common good" in society (something that belongs to both no one and every one, such as a public field where sheep can graze), people will tend to over-utilize it, until the common good is rendered useless (all the grass is eaten).[3] In this case, there is an argument for a central authority to fairly regulate the use of the good to ensure that all can use it but that it is not overused. By interfering in the free market, a regulatory authority can increase the welfare of all the parties involved.

Financial regulation presents many unique challenges over other types of regulation (environmental, workplace, product safety) because these market imperfections

[3]This example was first described by Hardin (1968) [13].

are not always black and white. Is our nation's growing income inequality a sign that the markets are not working or, as some might argue, that they are working? Is bank failure a sign of a healthy economy or a sick one? Should consumers expect protection from the government from poorly mad products or should they be responsible for determining the safety of what they buy themselves? All of these questions and many more come up in deciding how to best regulate a country's economic system.[4]

Regulatory Principles in the Finance Sector

Economic theory generally holds that there are essentially three justifications for regulation in the financial sector [2]:

- To maintain competition and curtail monopolies
- To correct information asymmetries that may be detrimental to the well-being of market participants
- To correct externalities, especially market failures that would be more costly than the sum of their costs (both private and regulatory)[5]

Much regulation in the US has focused on individual banks and mechanisms for ensuring system safety by keeping each bank safe, or is what is referred to as "micro-prudential" regulation. Two types of financial regulation often cited as especially important to our financial system—deposit insurance and minimum capital requirements—are primary examples of micro-prudential regulation. These are regulatory measures that focus very narrowly on maintaining the health of individual

[4]The unique political makeup of the US also adds the question of whether or not financial regulation, to the extent that it is necessary, be centralized in the federal government or administered at the state level. Hahn et al present a concise overview of the pros and cons of each regulatory schema. Arguments to centralize regulation include: better ability to regulate against all externalities, even ones occurring across state lines, economies of scale in regulation that allow national corporations to understand the regulatory landscape for the entire nation, avoiding a "race to the bottom" where states try to deregulate in an effort to attract business, the more efficient use of expertise, and the avoidance of undue local interest-group influence. Arguments to decentralize regulation to the state level include creating a diverse regulatory environment (the converse of the "race to the bottom" idea: creating a competitive "race to the top"), and the ability to experiment with different types of regulation across states [12].

[5]It is important to note that the financial industry is prone to unique externalities stemming from the fact that, unlike many other industries, banking institutions do a significant amount of trading amongst themselves; this inter-bank business increases the possibility of systemic externalities.

institutions while ignoring the macro characteristics of the system as a whole. For instance, consider a regulatory requirement that all banks be able to pay back 50% of their creditors within a day. As illustrated in 2-1 , bank A has $x deposited and then lends $x/2 to bank B (due at day t+1) and then bank B lends $x/4 to bank C and so on, we can see that no banks have violated the requirement, but at the same time default by a single institution may result in default by several institutions. If bank C cannot repay bank B, then bank B will also not be able to repay bank A, despite the fact that all of the banks complied with the regulatory requirements. An alternative to micro-prudential regulations such as capital requirements is the "macro-prudential" regulatory approach, which would instead seek to prescribe regulations that address the macro-state of the system. Essentially, "the object of a micro-prudential measure is to keep the individual institution behaving prudently, while that of the macro-prudential measure is to safeguard the system as a whole" [2].

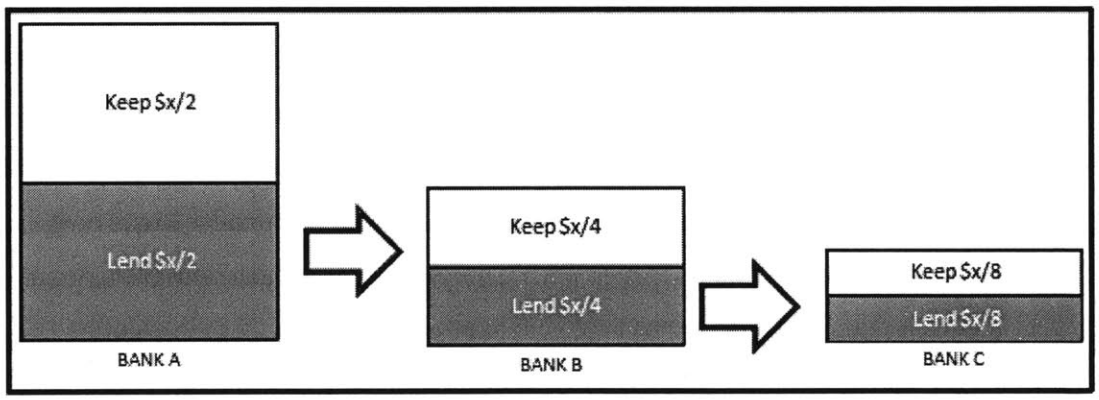

Figure 2-1: Simple Illustration of Capital requirement scheme

However, most of the regulation in the United States (especially at the time of the financial crisis) was decidedly micro-prudential in nature, and the regulation which is most important in understanding the Bear Stearns failure is micro-prudential regulation that attempts to keep individual banks from failing. The remainder of this section will discuss the concepts of solvency and liquidity in bank regulation and the various regulatory agencies that impact individual broker/dealers.

2.2.1 Solvency and Liquidity Principles

Solvency and liquidity are the two primary attributes of a bank's balance sheet that determine its health. Solvency describes the ability to pay debts. For an individual, that means simply that one is able to pay their bills—at least the minimum amount—as they come due. For an institution, solvency describes a firm's ability to meet its long-term expenses given its expected asset values—payments to bond holders, payroll, interest on loans, etc. Closely tied to solvency is liquidity. In the simplest terms, liquidity will sound almost identical to solvency—it's the ability of a firm (or person) to acquire the cash necessary to pay debts as they come due.[6] Understanding the relationship between solvency and liquidity for banks is important to understanding how crises like the credit crunch of 2007-2008 occur. Often, the co-mingling of solvency and liquidity issues is what drives a crisis. For example, in good economic times, a bank will base its positive solvency on the value of the assets on its balance sheet. Those underlying assets will have inherent value often based on future expected cash flows. But when the underlying value of those assets comes into question, as they did for mortgage backed securities in 2007, the liquidity of those assets (their current market price) may drastically change, impacting the

2-2 depicts a liquidity spiral as a reinforcing feedback loop that results in a solvency crisis. As the ease of borrowing money decreases, the need to liquidate assets increases, ultimately causing the perception that the firm has solvency issues, a notion that will accelerate the spiral. Note that the spiral depicted in 2-2 tacitly implies that borrowing money and liquidating assets are the only two means available for covering liabilities: this somewhat represents what occurred in the Bear Stearns case, but prudential measures—both by firm management and regulators—can aim to decrease this zero-sum game of financing.

[6]Liquidity is most often talked about on the asset level. That is, an asset is liquid if it can be easily exchanged for money. If I have a $1000 treasury note, my ability to exchange it for $1000 in cash (or close to $1000 in cash) almost instantly means that it is a very liquid asset. If I own a piece of art that I believe has a value of $1000, it may be difficult and time consuming for me to find someone to pay $1000 for that artwork, making it illiquid. Very often when we talk about the liquidity of a financial institution, we are talking about the aggregate liquidity of the assets that institution holds.

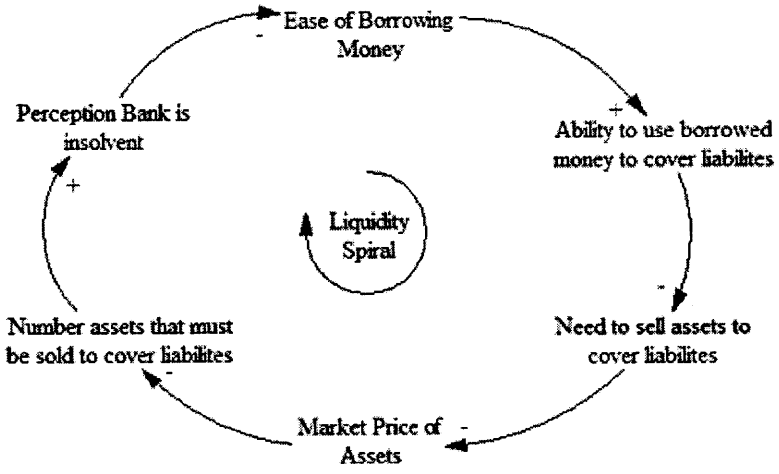

Figure 2-2: A liquidity spiral

There are many other aspects of our modern financial system that can work to compound the effects of this liquidity/solvency spiral. Many institutions are highly leveraged. This means that when they buy assets, they borrow a significant portion of the money necessary to purchase the asset (analogous to a homeowner taking out a mortgage with very little money down). This also means that in times of difficulty, they must sell even more assets at fire-sale prices, because they must sell enough both to pay their own debts and to pay back the money used to purchase the asset in the first place.

These two compounding aspects—being forced to sell at low market prices and the prevalence of leverage in the banking system—reflect two of the externalities often cited as rationale for micro-prudential regulatory interference in markets [2]. A liquidity spiral is seen as an market inefficiency because the actions of a single firm can have disastrous effects for other firms in the system, even if those firms never had any business with the original firm. For example, if Bank A is forced to sell a massive quantity of Asset A at fire-sale prices, Bank Z may feel the impact on their own balance sheet—both of the lowered market value of asset A and the likelihood

that the unraveling of a highly leveraged position ultimately affect Bank Z (when Bank A deleverages, and this forces Bank B to deleverage for similar reasons, which impacts Bank C, and so on).

2.2.2 The Existing Regulatory Schema

If we accept the avoidance of market externalities as adequate justification for financial regulation (or even if we do not accept it, but we do accept that modern society will create some form of financial regulation) the next most obvious question is: who should be regulated, and by whom? This question understandably elicits any number of vastly different regulatory schemes, as well as much debate and disagreement in financial regulation discussions.

A common distinction drawn in how institutions should be regulated is in how large and systemically important they are. Firms can range from the classic "too big to fail" (implicitly requiring both macro- and micro- prudential regulatory measures) to small firms with virtually no systemic connections (arguably requiring no regulation beyond general consumer protection measures). One of the major points of contention with schemes that regulate different institutions in different ways is the possibility that this will create conflicting incentives, most notably creating some degree of moral hazard in those institutions deemed "too big to fail." That is, if when designing a regulatory schema we decide that we will not allow certain institutions to fail and will always provide public bailouts, what is to keep the decision makers at these institutions from making unnecessarily risky choices?

The regulatory schema of the US at the time of the financial crisis was one that would graciously be called "complicated." It was born of the tradition of regulating based on industry segment—so investment banks would have one regulatory authority, insurer's another, and market makers another. Even the current US Code has a variety of titles that directly impact the financial sector—Title 12 ("Banks and Banking"), Title 11 ("Bankruptcy") , Title 15 ("Commerce and Trade"), and Title 31 ("Money and Finance")—and many more that indirectly impact the financial sector (Title 7, "Agriculture" governs the commodities markets). Completely understanding

all financial regulation and financial regulatory authorities is a drastically complex undertaking, one that may very well be infeasible for a single person. Consider only the agencies that most directly impacted the Bear Stearns case (or any large Wall Street investment bank in 2007) listed in 2.1—while their organizing structures are all similar, the laws that govern them and the powers and enforcement mechanisms they have vary wildly, yet they all exerted some degree of influence over a firm like Bear Stearns.

Because of the complexity of the regulatory schema at the time of the Bear Stearns accident, a complete "history" or overview of the regulatory practices of the time would be both necessarily incomplete and difficult to follow.[7] Instead, the following sections provide a brief overview of major regulatory shifts (or the lack thereof) in certain industry segments that are particularly important to the analysis of the Bear Stearns accident. The segments highlighted are investment banks (as opposed to commercial banks), Hedge Funds and other "Shadow Banks," and the practice of securitization.

[7] As well as duplicative: there is no absence of easily-available and high quality sources covering US financial regulatory history leading up to the crisis of 2007-2008.

Agency (Creation Year)	Location In US Code	Organization	Purpose	Regulatory Impact	Enforcement Powers
Securities and Exchange Commission (1934)	Title 15, Chapter 2B, Section 78d	5 presidentially appointed commissioners from both political parties (5 year terms)	Regulates the stock market and the sale of securities	Publically traded companies must submit audits and other reports to SEC; SEC enforces securities law	Can bring civil actions on individuals or companies violating securities law
Federal Reserve System (1913)	Title 12, Chapter 3	7 presidentially appointed board members (14 year terms), 12 regional banks with presidents picked by board (5 year terms)	Conducts monetary policy and regulates regional commercial banks	Strongly influences national interest rates; sets reserve requirements for commercial banks; is "lender of last resort"	Can change target interest rates; can lend (or not lend) emergency funds
United States Department of the Treasury (1789)	Title 31	Secretary presidentially appointed (member of Cabinet)	Promotes policies that create and maintain economic growth and stability	Produces currency; collects taxes; supervises national banks; enforces federal finance laws	Investigate and prosecute tax evaders, counterfeiters, forgers
Commodity Futures Trading Commission (1974)	Title 7, Chapter 1	5 presidentially appointed commissioners (5 year terms) from both political parties	Regulates commodity and financial futures and options	Creates regulations for commodities markets; enforces commodities regulations	Can bring civil actions on companies not following regulations

Table 2.1: Regulatory Agencies with direct impact on BSC accident

2.3 Segment Histories

The importance of the modern financial sector to our economic well-being is hard to understate. According to the Bureau of Economic Analysis' data on the impact of various industries on national GDP, the financial sector has consistently ranked the highest, even above goverment services, creating about 20% of our GDP every year between 2004 and 2010. While this is a very general look at the components of the economy, it is important to note that this data encompasses the boom years immediately prior to the crisis, the crisis itself and the years immediately following it. Throughout this period, the financial sector led all other sectors in its percentage added to GDP, with the next closest sectors barely more than half that of the financial sector.

The remainder of this section discusses the particular histories of various segments of the financial system relevant to the Bear Stearns failure and seeks to establish a history to inform the subsequent analysis. The specific segments that are discussed are Investment Banks, the so-called "Shadow Banking" industry, and the practice of securitization.

2.3.1 The Regulation of Commercial and Investment Banks

The regulatory distinction between commercial and investment banks is an important theme in the financial history of the US. For regulatory purposes, a commercial bank has historically been defined as one that takes deposits while an investment bank is one that creates and/or manages investment opportunities[8]—so there is the assumption that you can always get your deposits back from a commercial bank (perhaps with a small bit of interest if you are lucky) but you may not be able to recoup your investment capital from an investment bank (but you may also get it back with quite a bit of profit). When classifying these two fundamental institutional roles,

[8]The philosophical crux of the distinction is specifically that Investment Banks often act as underwriters to stocks and bonds, not merely that they advise on or execute general market trades. That is, Investment Banks work to create various stocks and bonds in an effort to raise capital for their clients. However, underwriting new securities can create a conflict if the Investment Bank is promoting products that might not be great for the client to buy, but are great for the bank to sell.

it is important to remember that both types of bank are for-profit businesses—they attempt to make money by using the money that their clients entrust to them. A commercial bank makes money by lending out some fraction of their deposits and charging interest on those loans. An investment bank makes money by making investments on stocks and bonds (buying a bond is similar to the commercial bank making a loan). The regulatory question is: can a single institution serve as both a commercial (deposit-taking) bank and an investment (risk-taking) bank? Or does acting in both roles introduce a fundamental conflict of interest?

The seminal US regulation dealing with commercial and investment banks is the Glass-Steagall Act, which was passed in 1933 as a direct response to the Great Crash of 1929. The act required that commercial and investment banks be separate: every bank must decide if it will be a simple lender (commercial bank) or a securities underwriter (investment bank).[9] The separation of bank duties remained a strong regulatory concern throughout the decades following the great recession, including a tightening of regulatory restrictions in 1956 when the Bank Holding Company Act prohibited bank holding companies (those that own at least two banks) from engaging in non-banking activity and from acquiring new banks across state lines.

Marketplace resistance to these restrictions began in the 1960s and 70s as investment banks created new types of accounts that pushed the theoretical limits of Glass-Steagall. For example, investment banks came up with a functional equivalent of a commercial deposit account with the creation of Money Market Funds (MMFs), investments in short-term highly-liquid debt (notably US Treasury bills). Firms tried to make MMFs look as much like commercial bank accounts as possible as a way to attract typical depository business, even providing traditional deposit account features like check-writing and debit cards. Likewise, pressure from commercial banks to be allowed to participate in the lucrative world of investments prompted the Federal Reserve Board in 1986 to interpret Glass-Steagall's language[10] to allow up to 5% of

[9]In addition to this separation of banking duties, the Glass-Steagall Act also established the Federal Deposit Insurance Corporation (FDIC), which insured commercial bank deposits and seeks to prevent future bank runs. More information on the FDIC can be found in Appendix B - US Financial Regulatory Agencies.

[10]Glass-Steagall prohibits commercial banks from being "engaged principally" in securities busi-

commercial bank revenue from investment bank business. This began an era of the Fed continually relaxing the standards of separation between banking and securities businesses, culminating in a 1996 Fed decision to allow bank holding companies up to 25% of their revenues in investment bank activities.

Throughout the 1980s and 90s there were numerous attempts to repeal Glass-Steagall, but none gained enough momentum to pass both chambers of Congress and become law. However, the 1998 merger between Travelers Insurance (which had acquired the Investment Bank Saloman Bros the year prior) and the commercial bank Citicorp to form the world's largest financial services company, Citigroup Inc created a new sense of urgency for lobbyists pushing for repeal. The Citigroup merger created a company that combined insurance underwriting, commercial banking, and securities underwriting—a clear violation of both Glass-Steagall and the Bank Holding Company acts. The merger creating Citigroup had been given temporary approval from the Fed in the fall of 1998, provided that within two years it was able to comply with existing regulations—that is spin-off or drop the lines of business in conflict. However, Citigroup never had to worry about this as a year later, in late 1999, Congress finally managed to repeal Glass-Steagall with the passing of the Financial Services Modernization Act.[11]

The turmoil around repealing Glass-Steagall begs the question: Why do investment banks exist? What is the value that the institution adds to the economy that commercial banks alone do not provide? One view holds that investment banks "have traditionally added value in transactions involving assets over which it is extremely hard to establish property rights" and that they "facilitate complex deals by creating a marketplace in which informal property rights over these assets could be created and enforced" [26]. That is, traditional investment banks have provided an information and liquidity market where one might not exist organically due to enforcement and protection infeasibilities. Morrison and Wilhelm track the evolution of investment banks from trans-Atlantic merchants of the 18th century, who enjoyed expansive ac-

ness, leaving the definition of "engaged principally" up to the regulatory authority—in this case the Federal Reserve Board.

[11] Also known as the Gramm-Leach-Bliley Act, after its Senate Co-Sponsors.

cess to information about counterparties and markets through their long-term trade networks. Eventually, these merchants found greater profit in trading on information (e.g. providing capital to new ventures or trading currency) than on trading physical goods. As trans-Atlantic communication mechanisms also advanced, these well connected merchants began to seek more and more of their profits through participation in financial markets and became the first investment bankers [26].

In the United States, the first major federal legal attention focused on banking and lending practices came with the Civil War, when the National Bank Act of 1863 established the Comptroller of the Currency (who had the task of chartering and regulating national banks) and created the first capital and reserve requirements for banks. Perhaps most importantly to investment bankers, the act also gave the Comptroller the ability to sell government bank notes backed by federal bonds, which investment banks could then sell to individual investors [29]. The postbellum years saw much financial turmoil, including many years of economic downturn and various liquidity crises occurring almost every 20 years. The Federal Reserve Act of 1913, which created the Federal Reserve System as a system of regional banks with one governing board, was seen as a compromise in the national debate of whether or not monetary policy should be centered at the federal or local level. This very lack of national federal identity is also cited as part of the reason the newly created Fed was unable to quickly control the Great Depression [29].

The onset of the Great Depression not unexpectedly brought with it many new pieces of financial regulation that greatly impacted those investment banks that managed to survive the depression. The aforementioned Glass-Steagall as well as the Bank Act of 1935 and the Emergency Bank Act of 1933 all sought to improve federal oversight of banks (largely through the Federal Reserve System, but also by creating other government authorities such as the SEC and the FDIC—see Appendix B - US Financial Regulatory Agencies for details on these agencies) and establish clear boundaries between commercial and investment banks.

For much of the 20th century, investment banks in America were dealmakers. The field was dominated by a few large banks that used reputation and extensive networks

to facilitate deals and move capital through the economy. These large banks were almost exclusively partnerships—privately owned banks that placed enormous value on the ability of their employees to land major deals through the development of reputations and person networks. This model meant that there was both an upper limit on the capital available to the firms—it was all coming directly from the pockets of the partners—but also that a lot of effort was placed in mentoring and grooming young employees for eventual partnership. For this reason, most investment banks had relatively low levels of bank capital but relatively high levels of human capital. However, the increased trading volumes and expected speeds that came with the introduction of computers into market infrastructure put pressure on the banks to change their business model. As technology demands increased, the only way for banks to afford the massive IT infrastructure necessary to remain competitive was to go public and raise capital through outside investors, which many banks did in the 1980s. Embracing the public ownership model also meant that human capital was much more mobile, as it was no longer tied into a partnership model where years of hard work at a single firm earned a powerful position within that firm [26]. This change from private to public ownership, and the resulting emphasis on productivity (what a single trader does at a public firm reflects more on that trader than the firm itself, and could easily help him or her get an even better job at another firm) has serious implications for how investment banks were incentivizing their employees at the time of the financial crisis.

After the political turmoil involved in the drawn-out repeal of Glass-Steagall, many other important pieces of legislation concerning investment banks drew relatively little political ire. For example, the SEC established the Consolidated Supervised Entity program in 2004, which allowed large investment bank holding companies to voluntarily submit to regulation, which most did because a consolidated regulator was a prerequisite for doing business in the lucrative European markets. Whereas after the repeal of Glass-Steagall the SEC only regulated the broker-dealer arms of investment banks but not necessarily their subsidiaries, after the CSE program began, investment banks and their subsidiaries were monitored. However, inclusion in the

Regulatory or Legal Action	*Year*	*Effect*
Federal Reserve Act	1913	Created the Federal Reserve System
Glass-Steagall Act; Emergency Bank Act	1933	Separates commercial and investment banks, increases federal oversight of banks
Bank Holding Company Act	1956	Extends bank restrictions (e.g. bank holding company with two or more banks can not engage in non-banking activity)
Federal Reserve Board Ruling	1987	Federal Reserve Board eases standards to allow banks to handle various underwriting business
Federal Reserve Board Ruling	1996	Federal Reserve Board rules that bank holding companies can own affiliates with up to 25% of their business in securities underwriting
Financial Services Modernization Act	1999	Repeals Glass-Steagall
SEC Consolidated Supervised Entity program	2004	Large bank holding companies can voluntarily submit to consolidated regulation

Table 2.2: Timeline of Important Legal and Regulatory Actions for Investment Banks

program allowed broker-dealers to use their own internal risk models to compute certain metrics about their own health, which some see as a downgrade in regulatory quality [8].

2.3.2 Hedge Funds and the "Shadow Banks"

The term "Shadow Banking System" is often used to describe any and all of the unregulated or lightly-regulated components of the financial system that existed at the time of the crisis. The FCIC Staff Report on Shadow Banking defines Shadow Banking as "bank-like financial activities that are conducted outside the traditional commercial banking system, many of which are unregulated or lightly regulated" [8]. Essentially, the shadow banking system provides the same functions as the traditional banking system, but in areas previously unregulated.

"Shadow Banking" can refer to either specific types of financial instruments (money

market funds, hedge funds, and investment banks are common examples) or types of interaction (the repurchase or "repo" market, auction markets, commercial paper, and derivatives are common examples).[12] A simplification of the distinction might be to think of traditional banking as the bank-based way to efficiently allocate capital and shadow banking as the market-based way to allocate capital.

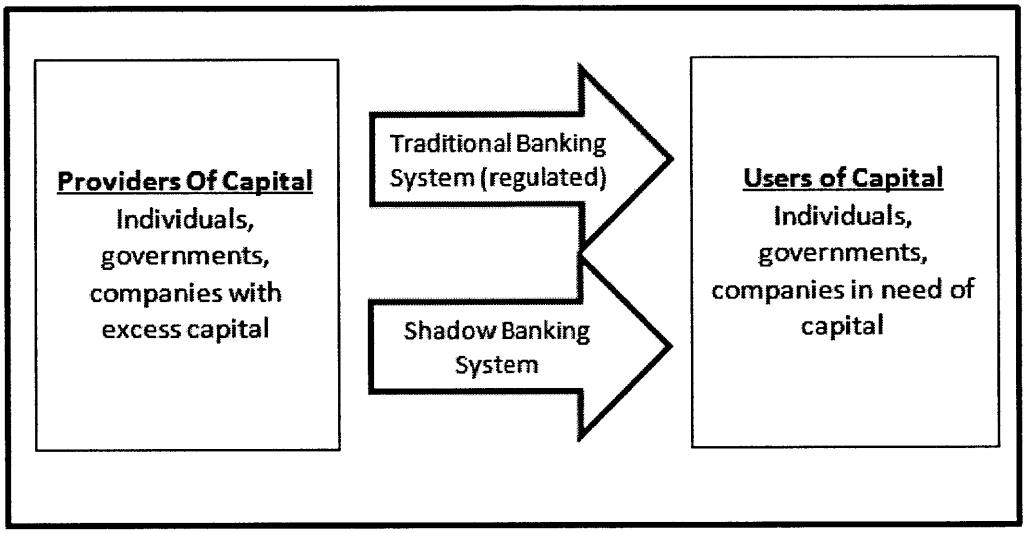

Figure 2-3: Traditional and Shadow Banking Functions.

Shadow banking is not inherently nefarious, but merely the product of a system that expands quicker than the regulations that govern it. In a sense, if I offer a friend a loan for a modest interest rate, we are a part of the shadow banking system, because we are engaging in the fundamental purpose of banking (creating credit) but in an unregulated space. Because there are probably an infinite number of ways to engage in "bank-like financial activities" outside of the regulated bank space, the idea of creating a regulatory scheme that will cover all possibilities is ludicrous. As such, most attempts to regulate non-bank entities have historically focused on investor protection rather than ensuring that the shadow bank is financially sound.

Because the Shadow Banking system is, by definition, outside of the regulatory system, there is not a lot to say about the history of its regulation. In fact, some might argue that the historic focus on the safety and soundness of banks as institutions

[12]For descriptions of what these instruments and transactions are, see Appendix A – Financial Products and Definitions.

(with limitations imposed on their activities by legislation, such as Glass-Steagall, and regulatory requirements on their balance sheets) coupled with the simultaneous laissez-faire treatment of the markets promoted the growth of market-based capital transfer mechanisms: shadow banking is the natural evolution of a regulatory schema that focuses on institutions rather than markets.

One important element of the shadow system is the hedge fund. Simply speaking, hedge funds are private investment companies. Legally, however, there is no codified definition of a hedge fund. Generally, hedge fund's clients are high net worth individuals or institutions that are looking for smart investors to grow their money. Hedge fund managers charge a fee, usually divided into a percentage (1-2%) of the assets under management as well as a portion of profits (up to 20%). Hedge funds can operate outside of the regulatory jurisdiction of the SEC precisely because they are private—they restrict the investor base and do not offer their "product" to the public (the 1940 Investment Company Act allows limited funds like this to be exempt from registration with the SEC). This lack of oversight and fierce competition between funds results in a high level of secrecy surrounding the funds. Often, little is known about their clients or assets under management, much less their specific investment strategies.

Most of the regulatory history of hedge funds surrounds the legal battle around the 2004 SEC rule that would require some hedge fund managers to register with the SEC—specifically those with more than 15 "clients." A subsequent legal battle (Goldstein v Securities and Exchange Commission) explored whether or not hedge fund managers were "investment advisers" because they had direct control over a pool of money (as opposed to a purely advisory relationship to investors). The SEC registration requirement was ultimately struck down as an arbitrary requirement [32].

2.3.3 Securitization

The process referred to by the term "securitization"—the pooling of various types of debt and selling the consolidated pools as a new security—saw dramatic growth in the forty years leading up to the financial crisis, largely due to the profound effect

of technological change on the process. At its heart, securitization exists so that immediate value can be found from long-term payments. This scheme emerged in the 1970s as a way to encourage broader investment in home ownership—the traditional Mortgage Backed Security (MBS)[13], first officially guaranteed by the infamous Governmental National Mortgage Association (GNMA), or Ginnie Mae. The popularity of MBSs (and Asset Backed Securities, the same idea but with payment streams not tied to mortgages) rapidly increased in the following years, as did the ease of creating them: The ability to compute huge probabilistic and mathematical models very quickly has allowed for the type of complex securitization that would never be possible if done by hand. Governmental policies in the 1990s meant to increase home ownership also had a hand in the rise of the MBS market.

Many cite the federal push towards home ownership as bringing about the prevalence of the "originate to distribute" model of mortgage origination [3]. Under this model government policies meant to promote home ownership created an attractive market for investors to create residential mortgages that they had no intention of holding onto and thus little care if the borrowers were a risky bet or not. Essentially, "incentives between lenders and investors diverged markedly as the former were not required to retain a sufficient portion of the risk associated with the loans that they securitized" [3]. Policies to align incentives, such as the Federal Reserve's Regulation Z (which prohibits loans that do not take into account the borrower's ability to repay) were not introduced until after the financial crisis.

Another important aspect of securitization is the information available to investors looking to purchase securities, which consists of the disclosure information provided by the issuer as well as the rating given by the credit rating agency (CRA). Disclosures of many of the so-called toxic assets have been found after the fact to be inadequate. Disclosure is governed largely under SEC regulation AB, which dictates the data that must be made available for asset-backed securities, but does not require individual loan-level data.

[13]The details of MBS and ABS securities can be found in Appendix A – Financial Products and Definitions.

The other important piece of investor information is the rating issued by a credit rating agency (CRA). There are three big "Nationally Recognized" credit rating agencies—Moody's, Standard & Poore, and Fitch. The CRAs have a unique role in that they serve as "gatekeepers to the global credit markets" [3]. Regulatory oversight of the operations of the CRAs is slim—the first instance of any regulatory attention came as late as 2006 with the Credit Rating Agency Reform Act, which established the designation of "nationally recognized statistical rating organization" (NRSRO) which means that the agency follows certain procedures for issuing and verifying credit ratings and takes steps to avoid conflicts of interest with their clients.[14]

[14]The most obvious conflict of interest, of course, being that their clients are the very organizations for whom they are determining ratings.

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Chapter 3 Bear Stearns History

"I just simply have not been able to come up with anything, even with the benefit of hindsight, [which] would have made a difference."

- Alan Schwartz BSC CEO, in the New York Times, May 2008

This chapter will move beyond the context of the financial system as a whole and attempt to sketch a short history of Bear Stearns as a firm—most importantly focusing on its corporate culture and major market activities leading up to the 2008 accident.[1] The purpose of this chapter is to give the reader an idea of what Bear Stearns's role in the market was at the time of the accident and how corporate policy and culture might have contributed to "operator" decisions in the context of the accident. That is, a glimpse into what might have shaped the mental models of executives and traders at Bear Stearns as well as their counterparties and regulators. Out of a combined desire for brevity and lack of detailed information, this chapter is necessarily a very "macro" view of the Bear Stearns organization.

3.1 The Beginnings

In the years leading up to its 2008 demise, the Bear Stearns Companies, Inc (BSC) had a reputation for being a scrappy but serious Wall Street player: Of the five big broker/dealers on Wall Street,[2] BSC was the firm most ready for a fight. BSC was relatively young compared to other venerable Wall Street names, having been founded in 1923 by Joseph Bear, Robert Stearns and Harold Mayer. Through the careful

[1]The source of the details in this chapter are from [4, 8, 5, 17, 18, 16].

[2]The five big banks of the era were Bear, Goldman Sachs, Morgan Stanley, Merrill Lynch, and Lehman Brothers. Within a year of the financial crisis, all of these investment banks had essentially become commercial banks or gone under—Lehman through bankruptcy, Bear and Merrill through acquisition, and Goldman and Morgan through mergers.

efforts of the managing partners, the firm managed to survive the onset of the Great Depression and by 1933 had grown its capital from the original $500,000 to $800,000 [4]. Bear was known as a firm that always had strong leadership: Since just after the Second World War until shortly before its demise, it had only three top executives, Salim ("Cy") Lewis, Alan ("Ace") Greenberg, and James ("Jimmy") Cayne. These three men did much to create BSC's reputation as a "scrappy upstart."Many would say the moniker could easily apply to any of them personally: of the three, only Greenberg had finished college, and all of them worked their way up through the ranks of the firm to its top position.

In 1985 Bear, like many other firms on Wall Street, became a publically traded company (refer to the discussion in Chapter 2 of the technological forces that pushed many investment banks into issuing IPOs). In becoming a public firm, BSC replaced "partners" with "shareholders" on the list of interests it had to protect—which also included bond holders and clients (BSC served corporate, institutional, governmental and individual clients). At this time, the name "Bear Stearns Companies, Inc" officially referred to the holding company that controlled many subsidiaries in a wide variety of businesses. According to Mergent Bank and Finance Manual of 2008, Bear was at the time of its demise, "a global investment banking, securities and derivatives trading, clearance and brokerage firm operating in three principle segments: Capita Markets, Global Clearing Services and Wealth Management." These three lines of business are further broken down in 3-1 , and explanations about the detailed functions of each can be found in Appendix C – Bear Stearns Lines of Business [25]. In 2007, 66% of Bear's $16.1 billion in revenue came from the Capital Markets segment, while Global Clearing and Wealth Management brought in 20% and 14%, respectively [34].

3.2 The Boom Years: 1990 through 2006

During the 1990s and 2000s, BSC had a reputation of being a big player in the fixed income markets and a relatively weak player in the equity markets. This fixation

Figure 3-1: Major Business Lines of Bear Stearns in 2008

on debt instruments has a long history in Bear Stearns corporate culture. A risky but ultimately fruitful bet on railroad bonds during World War II is part of what launched Cy Lewis into the top management position at Bear in the post-war years. This focus seemed to be a mistake during the bull market of the 1990s, when, in an effort to compete with equities-centric competitors, BSC turned to expense-saving measures and become one of the first Wall Street firms to have layoffs, cutting more than 1300 employees in 2000. However, many analysts ultimately applauded the fixed-income

centric strategy when BSC saw record earnings growth after the dot-com burst (on the order of 55 percent in the first quarter of 2003, at a time when most Wall Street firms were struggling through a down market) and minimal exposure to the banking scandals of the day that were tarnishing its competitors [33].[3]

Much of the media attention focused on Bear in the 1990s and early 2000s included glowing revues of the company's risk management and executive committees, including its brusque CEO, Jimmy Cayne. Cayne had a reputation of being a tough, no-nonsense negotiator who always placed the well-being of his firm as a top priority. A seminal example of this—and one that earned Bear few friends on Wall Street—was BSC's role in the failure of the Long Term Capital Management (LTCM) hedge fund. LTCM, founded in 1991, was a fund based on high leverage and complex mathematical trading algorithms[4] meant to produce staggering results for its wealthy investors. Because BSC acted as clearing house for LTCM, when the fund experienced a liquidity crisis in 2008 and underwent a Federal Reserve organized bailout (where the bailout funds were provided by the major creditor institutions), all of the other Wall Street firms were shocked when Cayne announced that Bear Stearns would not participate in the bailout. Cayne argued that Bear's role as clearing house for LTCM did not obligate it to bail the fund out because they had not taken on direct counterparty risk to LTCM trades where other banks had. Needless to say, the other major banks were very angry over Bear's refusal to participate, and resentment toward the firm brewed for many years.[5]

[3]Bear Stearns was not, however, immune to scandal during the years surrounding the turn of the twenty first century. Most notably, in 1999 Bear paid a $38.5 million fine to the SEC for its involvement with a fraudulent penny-stock brokerage, A.R. Baron.

[4]Tellingly, LTCM's motto was "The Financial Technology Company."

Chapter 4 A CAST Analysis of the Bear Stearns Collapse

"The rumors themselves were not true until the telling of the rumors created the truth."

-former BSC Chief Operating Officer Paul Friedman at the FCIC hearing on May 5, 2010

This chapter presents the CAST analysis of the events leading up to the government-sponsored bailout of The Bear Stearns Companies, Inc (BSC). There are three basic steps to the CAST analysis: (1) setting the stage, which includes hazard identification, safety requirements, and documenting the safety control structure in place at the time of the accident; (2) accident specifics, which will provide a proximal timeline of the accident, analyze roles of system components during the accident and identify failures and dysfunctions that contributed to the loss of control; and (3) accident analysis, which will address failures higher up the control structure. Chapter 5 provides a discussion of the analysis and recommendations derived from it and will synthesize the findings into concrete regulatory recommendations to avoid future similar losses and compare CAST results with the congressional inquiry into the event.

Caveat

Application of the CAST accident analysis model—or any accident analysis model—is certainly most effective when completed by an analyst that works in the industry and is very familiar with the accident in question. Because I do not work in the financial industry and only know the details of the incident as portrayed by the media, this analysis may inherently suffer from lack of details as to how, precisely, BSC ran their business and how control and feedback flowed within the firm at the time of the accident. However, I would like to suggest that any flaws in the analysis caused by necessary assumptions on my part only point to how much stronger a systems-based analysis such as this might be if conducted by industry insiders.

4.1 Setting the Stage

"Are you using the argument [...] that you're human? Is that your fall-back?"

-Hon Bill Thomas,
Vice Chairman of the Financial Crisis Inquiry Commission,
during questioning of former Chief Operating Officer of Fixed Income of Bear Stearns, Paul Friedman

The following sections go through the preliminary steps of the CAST process: first to identify the high level system and hazard(s) involved in the accident and then to identify the general Safety Constraints and System Requirements [19].

4.1.1 Hazard Identification

The accident under analysis here is the March 13, 2008 near-insolvency of The Bear Stearns Companies, Inc (BSC). On that date, BSC declared to their primary regulatory authority, the Security and Exchange Commission that they would be unable to operate normally the following day (e.g. they would be insolvent) and only avoided filing for bankruptcy via last minute aid given by the Federal Reserve bank and JP Morgan.

There are many different ways to deconstruct the insolvency of a bank into a concrete accident, but the most direct is to rely on the accounting definition of solvency. A solvent entity will have a balance sheet that satisfies the basic equation:

$$\text{Assets} = \text{Liabilities} + \text{Equity}$$

Because constant maintenance of this equality is central to the bank's ability to operate normally, it will serve as a proxy for physical failure in this accident. The systems involved in the accident will be divided between those that control or influence the three components of the equation above, or in CAST terminology, the operators with control over each physical component.

Primary systems and their high-level components involved in accident:

- Asset Contributors
  - Traders at firm (buy and sell assets on the market)
  - Creditors to the firm (lend money or assets to firm)
  - Clients of the firm (provide fees and assets)
- Liability Controllers
  - Management of Bear Stearns—responsible for protecting shareholders and managing risk
  - Traders at Bear Stearns—responsible for day to day balance sheet
- Equity Contributors
  - Shareholders

The primary safety system in place consists of the US financial regulatory bodies with oversight over BSC and the market in which it operates. The three below are the primary regulators associated with this case.

- **The Federal Reserve Bank**
  - Oversees markets, sets interest rates, serves as lender of last resort to commercial banks
- **The Securities and Exchange Commission**
  - Monitors balance sheets and health of investment banks
  - Monitors details of securities on the market
- **The US Department of Treasury**

High Level Hazards:

Hazards are defined by Leveson as "A system state of set of conditions that, together with a particular set of worst-case environmental conditions, will lead to an accident (loss)" [19]. This means that hazards are not the same as accidents: hazards can exist without an accident or loss ever taking place, but the converse is not true: any accident in the system is a result of the system entering a hazardous state. With that in mind, the accident of a failed investment bank can be considered in the context of the following states of the bank:

- Cash Flow Insolvency (e.g. bank is unable to fully pay debts as they come due)
- Balance Sheet Insolvency (e.g. bank liabilities exceed bank assets)
- Inability of the market to value firm's assets
- Inability of the market to know firm's health

Note that the hazards concerning insolvency carry different implications. The first, Cash Flow Insolvency, occurs when there is not enough cash available to pay debts but there may be plenty of underlying illiquid assets. The second, Balance Sheet Insolvency, is when the bank has more liabilities than assets, which may occur because the bank makes a poor decision or may simply occur when market conditions suddenly change. For example, I might be Cash Flow Insolvent when I cannot pay my mortgage payment, even if my house is now worth more than it was when I bought it. Likewise, I would be Balance Sheet Insolvent if my house drastically decreases in value and I now owe more than it is worth.

These primary contexts are listed as system hazards in 4.1.

H1	Bank cannot pay debts (illiquid assets)
H2	Bank has greater liabilities than assets less equity
H3	Market is unable to determine value of a financial instrument
H4	Market is unable to determine creditworthiness of institution

Table 4.1: High level BSC hazards

There is some nuance involved in each of the hazards worth discussion. H1 and H2 deal directly with a firm's balance sheet and how it is managed. H3 and H4 concern how the market is able to determine the relative value of components in the system. A very simple system might leave H1 and H2 up to individuals and firms and rely on regulatory authorities to protect against H3 and H4. Some more libertarian observers might make the argument that H3 and H4 are by definition impossible because if the market cannot determine the value of something, then its value is inherently nil. However, this analysis assumes that the market is imperfect and may not be able to accurately value instruments or institutions that do, nevertheless, retain some positive value.

4.1.2 Safety Constraints and System Requirements

Here we encounter one of the primary areas where the fundamental nature of the financial industry will affect the CAST analysis. Whereas in a physical system general safety constraints are easy to define and will be universally accepted (e.g. "Aircraft must maintain separation from other aircraft" or "Patient must not be exposed to unnecessary radiation"), many of the safety constraints that might seem most obvious for an investment bank may very well be in direct violation of the operational requirements of the firm. For example "Firm must be able to repay all debts at all times" might seem like a good way to keep a bank from becoming insolvent, but it would also keep that bank from making any profit and would ultimately destroy the accumulative power of the financial market. As it is impractical to assume that the fundamental tenets of the financial system must (or can!) be re-engineered, this analysis accepts that there is inherent risk and even greed at play in financial markets that cannot be engineered out. For the purpose of this analysis, I will attempt to define general safety constraints that will not greatly curtail the firm's ability to take risks in order to create wealth.

Defining general system requirements is also problematic for the financial sector in its capacity as an evolved social system. Our economy has evolved under relatively

laissez-faire conditions, and the debate as to whether or not that should be the case certainly influences the outcome when defining system requirements. In an effort to avoid political assumptions about what a good financial system should accomplish, this analysis will continue in the laissez-faire tradition and focus only on the requirements directly related to the safety constraints. In other words, this analysis will take the basic assumption that a financial market can regulate itself (the "invisible hand") as long as there are no externalities such as information asymmetry. This approach tacitly allows for a system requirement that market participants are able to maximize personal profit as long as they do not violate the safety constraints. The discussion of the inherent safety or efficacy of a market that allows for personal profit maximization (as opposed to one that, say, requires some sort of profit equality across participants) is an important one to have, but not within the scope of this analysis.

Hazard	Safety Constraint (SC)	System Requirement (SR)
H1	SC1: Bank must be able to pay debts as they come due.	SR1: Bank must have adequate short-term assets and/or capital to cover short-term liabilities.
H2	SC2: Bank must always have solvent balance sheet.	SR2: Bank must not acquire liabilities that exceed its assets and capital.
H3	SC3: Market Participants must be able to determine value of market instruments.	SR3: All financial instruments traded in the market must have adequate information available to determine their inherent relative value.
H4	SC4: Market Participants must be able to determine creditworthiness of bank.	SR4: There must be a clear and unbiased source of information about Bank's health available to the market.

Table 4.2: BSC Safety Constraints and System Requirements

4.1.3 Roles and Responsibilities

The primary components of the system (identified earlier as components of the Primary System) are listed below, along with their primary roles and responsibilities

Stakeholder	Responsibilities
BSC Managing Executives	Protect shareholder interests by increasing value of the firm.[1] Monitor health of balance sheet of firm and the decisions of traders that impact it. Provide necessary data to market participants about state of firm. Determine long-term strategy, including firm's risk appetite.
BSC Traders/Fund Managers	Create profit for firm. Accurately and regularly report on short-term status and details of investment and accounts to managing executives.
Market Investors BSC Shareholders BSC Creditors BSC Counterparties	Understand underlying strength of firm, calibrate interaction with firm accordingly.[2] Understand details of own investments made; accept risk of not understanding details.
Regulators Federal Reserve System SEC US Dept of Treasury	Ensure no fraud or misleading tactics. Ensure that firms are accurately represented to investors and meet minimum safety requirements for market participation. Determine regulatory requirements for financial reporting. Enforce regulatory requirements for financial reporting.

Table 4.3: Roles and Responsibilities

within the system.

Because the financial market is primarily an information market, most of the roles and requirements of participants are directly related to the cultivation, transfer and evaluation of information. This analysis assumes that no market participants in the BSC case engaged in outright fraud and that no information was purposely misrepresented.

[1]Remember that most managing executives are themselves significant shareholders.

[2]This responsibility may seem a bit confusing. Essentially, it is allowing that all market participants outside of the firm in question have the ability to interact with the firm in the market. However, this right comes with a responsibility to understand, based on available market information, the health of the firm and to calibrate interactions with the firm accordingly. Depending on the risk appetite of market participants, this "calibration" may mean eliminating all exposure to the firm or it may mean increasing exposure to the firm or changing the fees associated with lending money to the firm.

The fact that information—as opposed to physical or mechanical components—provides all of the control in this system creates unique challenges to understanding the control structure presented in the next section.

4.1.4 Safety Control Structure

Because of the nature of the hazards under consideration in this analysis, the safety control structure for the system will focus on the BSC balance sheet (Assets vs. Liabilities and Capital) as the physical process under examination and information and changes to that balance sheet as the control mechanisms in place. Note that several technical details of the balance sheet are ignored for this exercise. Because operational aspects of the balance sheet such as payroll and physical capital are not related to the accident in question, this control structure abstracts the balance sheet to just represent very general "asset" and "liabilities" categories. All of the control and feedback flows shown in 4-1 are related to the financing and trading operations at BSC.

Another unique aspect of this control structure is the potential for conflicts of interest, that is, when a single person or business may be acting in several capacities. Most obviously, almost all BSC employees are also shareholders, a fact not captured in this diagram. Additionally, the sub-system of "The Market" deserves notice. One might argue that "The Market" should be the largest box, encompassing everything else. However, because the goal of the analysis is to understand the failure of a single institution, considering the market as something external to BSC is a justifiable simplification. Additionally, "The Market" is a unique subsystem in that it can exert its own control in the form of prices without a direct link to any of its sub-components. No single entity within the market determines or creates prices, the market as a whole does that. Additionally, the control structure shows that it is primarily market forces that impact the BSC balance sheet and not BSC employees themselves. BSC traders made deals (to buy or sell, lend or borrow) with market counterparties. The terms of those deals are what directly impact the balance sheet. If this premise seems doubtful,

try to imagine a scenario in which a BSC employee can impact the balance sheet without interacting with a market counterparty. Barring directly infusing the balance sheet with personal assets (and thus, in effect, becoming a shareholder), any change to the balance sheet (adding either liabilities or assets) cannot be completed without a willing market counterparty. So it can be said that the only entities with direct control over the BSC balance sheet are market counterparties: they are "controllers" who can accept or reject the terms posed by BSC employees.

The control structure in 4-1 also makes several simplifying assumptions about the control mechanisms in the market and in the firm. Because it is hard to know exactly how the various business units in BSC were structured, this diagram assumes the most elementary structure based on the three major business units as described in Chapter 3. Under this Structure, the three business units are as follows:

Capital Markets Unit: This unit most directly impacts the balance sheet and represents the Equity and Fixed Income Traders that buy and sell assets for the firm balance sheet. The Capital Markets Unit also represents the financing operations of the firm, i.e., the engagement in the repo and commercial paper markets for short-term financing and in selling corporate bonds for long term financing. Ideally, information would be available to understand how control flowed within these separate entities at the firm. As that is not easy information to get (or to guess), all of these functionalities are grouped into one unit under the assumption that the person in charge of that business unit has equal control over all underlying functionalities of the unit. For simplification, this unit faces two counterparties in the market—creditors from whom it takes loans (creating assets and liabilities on the balance sheet) and counterparties with whom it buys and sells assets, which impacts the assets side of the balance sheet.

Clearing Services Unit: The business unit that provides help with the transactional, not strategic, details of trading to customers. For simplicity in this thesis, this unit is seen as providing a service for a fee to a customer. This unit then produces assets on the balance sheet (fees charged, money made, and possibly limited use of customer assets) and liabilities (providing clearing services means that BSC is now responsible for customer assets).

Wealth Management Unit: The business unit that provides account management and advice for wealthy individuals and institutions and thus incurs assets (fees) and liabilities (customer accounts).

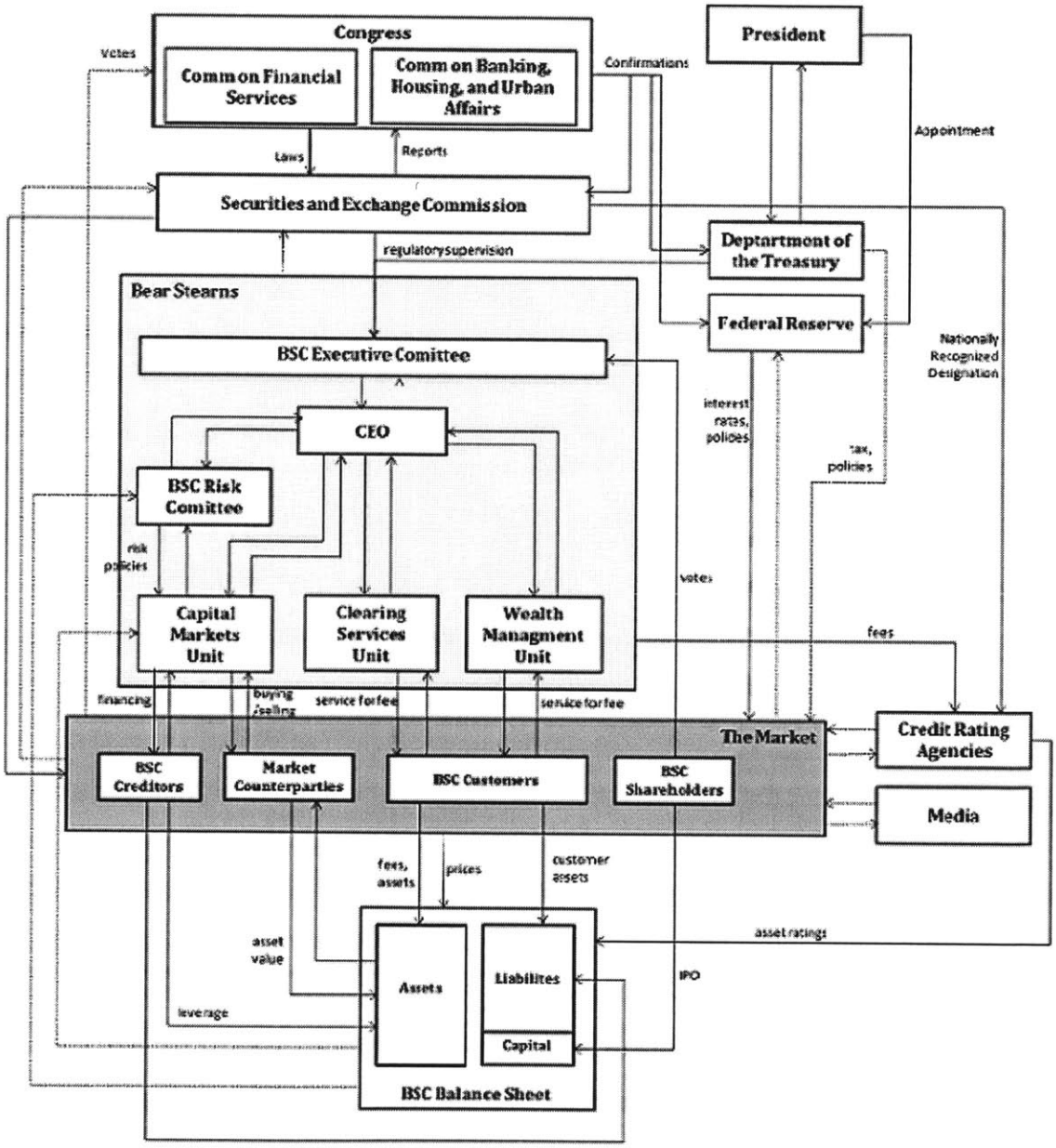

Figure 4-1: BSC High Level Control Structure

4.2 Accident Specifics

Below is the condensed version of the accident timeline and the safety control structure based on the details discussed in Chapter 3. All of the detail of the BSC business model and the events leading up to the failure of BSC are in Chapter 3.

Proximal Event Chain

Item 15 (bolded) is the "accident" under consideration in this analysis.

1. Housing Market Collapse; commercial paper and repo markets begin to tighten (early 2007)
2. BS's two managed hedge funds declare bankruptcy (July 31, 2007)
3. S&P downgrades Bear to 'negative outlook' (August 3, 2007)
4. Head of Fixed Income asked to leave after hedge fund failure (Fall 2007)
5. Bear decreases mortgage exposure 20% (Aug, Sept 2007)
6. Federated Investors drops Bear as an approved counterparty for unsecured commercial paper (Oct 1, 2007)
7. Bear strategically begins to rely only on secured lending (repo) for short-term financing (2007)
8. Bear reports fourth quarter loss, SEC maintains that BS liquidity pool is "stable" (2007)
9. Bear CEO Jimmy Cayne resigns (January 2008)
10. Bear treasurer reports internal accounting error with result that liquidity is $5b less than thought; SEC demands daily liquidity reports from Bear (Jan 30, 2008)
11. SEC inspects Bear's liquidity pool, finds "no significant issues" (March 3, 2008)
12. Moody's downgrades 15 MBSs issued by Bear, investors begin to panic (Monday, March 10, 2008)
13. Federal Reserve announces plan to lend to investment banks at end of March (Tuesday, March 11, 2008)

14. Goldman Sachs refuses to enter into standard counterparty novation with Bear for small position ($5m) that they agree to (at a higher execution fee) the following day (Tuesday, March 11, 2008)

15. Media reports on GS refusal, Bear pays out $1.1b in margin calls (Wednesday, March 12, 2008)

16. **Bear informs the SEC it will be "unable to operate normally" the next day, New York Fed makes $12.9b loan to Bear (Thursday, March 13, 2008)**

17. NY Fed informs Bear the loan will not extend past the weekend (Friday, March 14, 2008)

18. JP Morgan, with financial support from the Fed, makes deal to buy Bear for $2 a share (Sunday, March 16, 2008)

19. Bear and JP Morgan agree to raise price to $10 a share (March 24, 2008)

4.3 Accident Analysis

Physical Level Analysis

A high-level analysis of the physical system invovled in the accident.[3]

System: The Bear Stearns Companies, Inc Balance Sheet

Safety Requirements and Constraints Violated

- Insufficient liquid assets to cover liabilities ("unable to operate normally") on March 13, 2008
- Short-term secured funding suddenly unavailable
- Willing counterparties suddenly unavailable
- Capital reserves insufficient to cover run on bank

Context—Safety Controls

- BSC Risk Committee monitors balance sheet, sets internal risk goals and policy
- SEC and US Treasury regulates BSC for health of the company
- Credit Rating Agencies publish credit rankings for BSC
- Credit Rating Agencies publish credit rankings for assets on BSC balance sheet
- Firm Traders monitor balance sheet and know when liabilities come due
- Certain types of asset (e.g. Agency Debt) are equivalent to cash in terms of value as collateral
- Liquidity cushion of $18B (March 10, 2008), considered adequate to cover market movements
- Assumption that value of fixed income instruments will not change

[3]Because the physical system in this case is a balance sheet, it is important to keep in mind the role rumor and perception can play on the physical system itself—a unique characteristic that is not present in physical systems involving pulleys and levers. For example, consider the trivial example of a sealed envelope as the "physical system." If I were to ask you how much you would pay me to have what is inside the envelope and do not give you any more information, your price will be very low. If I tell you there is a winning lottery ticket inside, it may go up. If you know that I had a winning lottery ticket earlier in the day, it would go up even more. If our mutual friend told you that I was a liar who often pretended to have tickets, it would probably go down. Throughout this process, the physical system itself has not changed—it is still a sealed envelope with something of fixed value within. However, your perception of its value—and thus the market price you are setting—has changed repeatedly. If that envelope were the only "asset" on my balance sheet, the health of that balance sheet could have been in many states without any change to the asset itself.

Failures

- Firm balance sheet allowed to maintain long term high leverage ratios
- No risk analysis or planning for worst-case bank run scenarios
- No significant downside to traders or management for massive company losses
- Minimal federal oversight on how credit rankings of assets are determined
- No clear regulatory standard on minimum capital or maximum leverage requirements
- No regulatory oversight or understanding of systemic complexity

Contextual Factors

- Highly technological and public nature of financial sector means that human capital is highly mobile—traders can easily move between firms, so firms are working to keep employees happy
- More engineering and mathematical approach to finance in last 20 years has resulted in many highly complex financial instruments that are difficult to understand
- Agencies responsible for benchmarking financial instruments and institutions is funded by the institutions they rate

4.3.1 Higher Level Analysis

In order to perform the high –level analysis, it will be necessary to focus on specific areas of the control structure. Primarily, we can reduce the primary control mechanisms down to a classic control loop with the common elements that lead to an accident as described by Leveson [19] and the main components (Controller, Actuator, Process, Sensor) labeled. This version is simplified from the original control structure (4-1) in order to avoid dealing with internal BSC hierarchical controls (which are important but outside of the scope of this analysis) and distinctions between various market participants.

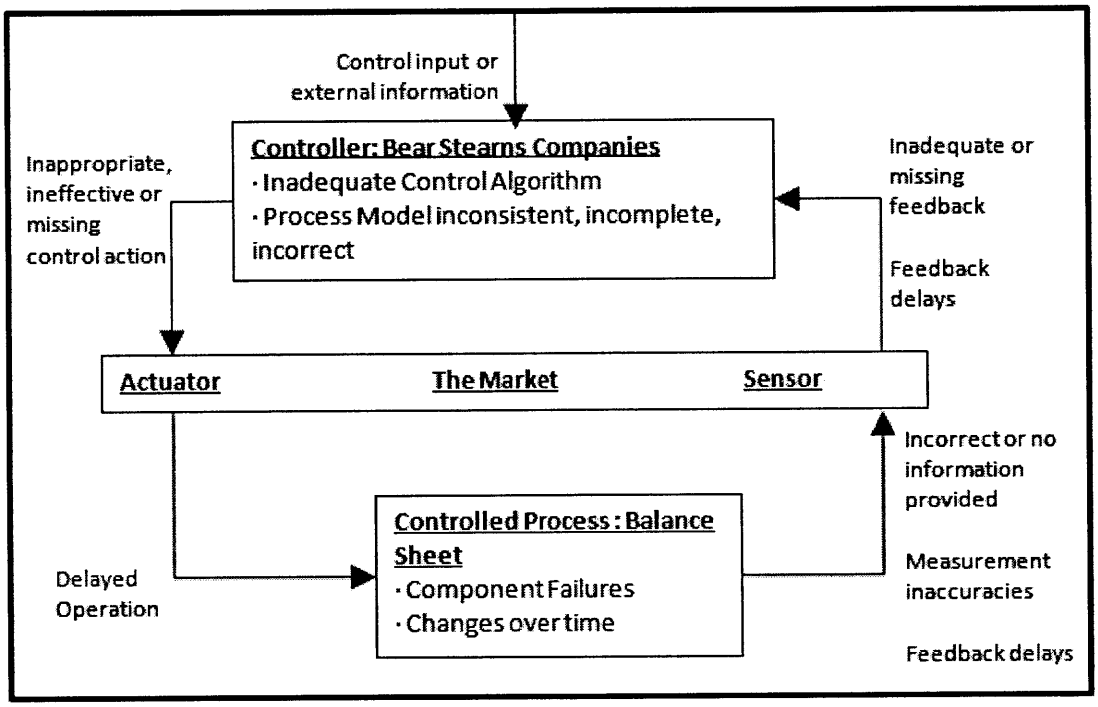

Figure 4-2: BSC Balance Sheet as a Controlled Process as defined by Leveson (2012)

Putting the events of March 2008 into the context of this loop is a useful next step before moving on to the high-level analysis of the system. In order to complete the high-level accident analysis, we must next understand how each of the generic control loop flaws listed above can be mapped to events occurring during the Bear Stearns collapse. Note that the elements of 4-2 could also be applied to regulatory control over BSC, where federal regulators are the controller and BSC and its Balance Sheet

are the Controlled Process.

4.4 below expands all of the items in the loop shown in 4-2 for the BSC example, starting from the top and moving counter-clockwise around the loop, to show how the physical causes can be seen in terms of a control problem. This step is intended to demonstrate how well the events of March 2008 fit into the control loop framework of CAST, and how (when viewed with the benefit of hindsight) there were potential flaws in many parts of the control loop.

The causes highlighted in 4.4 do not aim to be exhaustive, but should give the reader an idea of how to structure their thinking when translating the BSC case into system-theoretic control loops.

The next step of the analysis is to systematically examine the higher levels of the safety control system. The system components are divided into three basic groups with each group having roughly equivalent requirements, contexts, responsibilities, and process model flaws, as illustrated in 4-3 .

In this case, because this analysis is based on limited information about how BSC operated and interacted with regulators, narrowing the higher-level components into those shown in 4-3 allow for a more understandable analysis.[4] Additionally, it becomes clear what a pivotal role "The Market" plays in BSC's ability to exert control on its balance sheet. Given this important role, I will also treat the market as a high-level controller, while acknowledging that this is a major simplification because the market is not endogenous to any component within the system. While the market is not a controller in the traditional sense of the term, the roles it plays in both exerting control over and obtaining feedback about the state of the balance sheet (a sort of simultaneous "actuator" and "sensor") give it a role that can be analyzed as a controller.

4.5 , 4.6 , and 4.7 explore the high-level roles of the firm (BSC), other market counterparties, and federal regulators in the accident and present the necessary context

[4] A complete CAST analysis done by an analyst more familiar with BSC/regulator/market interaction protocols would be a terrific advancement of this work.

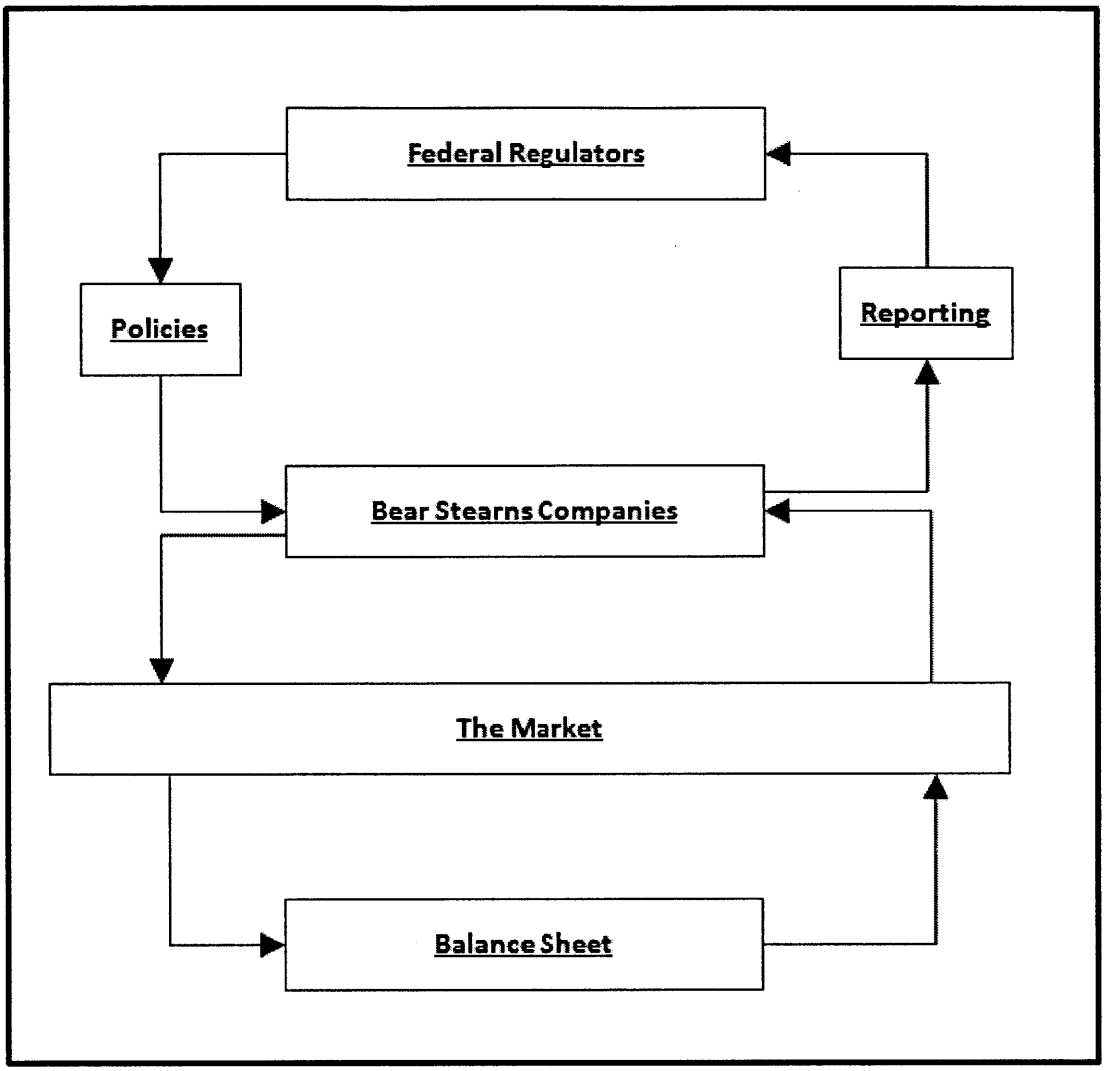

Figure 4-3: BSC Reduced Control Loop

for the final analysis and recommendations.

Process Model Flaw	BSC Accident Example – BSC as Controller
Control Input/ External Information Wrong or Missing	· No clear regulatory requirements on acceptable leverage ratio · No clear regulatory requirements on use of complex financial instruments · No push from stockholders to reduce risk · No regulatory oversight of complexity/systemic risk
Controller has Inadequate Control Algorithm	· Conflicting Incentives (pay structure) for employees · No mechanism for sudden change in asset prices on leveraged assets or collateral · No mechanism to address rating downgrades
Controller Process Model Inconsistent, Incomplete, Incorrect	· Believed housing prices could not fall · Believed certain assets would always be accepted as financing collateral, regardless of state of company · Believed high leverage could be unwound in an orderly way · Believed market perception would be based on fact (balance sheet, cash flow, etc)
Inappropriate, Ineffective or Missing Control Action (to Market)	· Did not deleverage in time · Did not sufficiently reduce exposure to MBS instruments · Did not find reliable source of financing
Inadequate Actuator	· Market would not accept agency debt as collateral
Delayed Actuator Operation	· Market (Goldman Sachs) sent delayed marks on assets · Market delayed in determining correct market value of assets
Controlled Process Component Failure/Changes Over Time	· Market changes did not impact liabilities/assets equally
Absent/Inaccurate/Delayed Information to Sensor	· No recent balance sheet reports · Trade Secrecy keeps trading strategies from the market
Inadequate Sensor	· Rapidly changing asset prices reduced confidence · Rapidly changing credit ratings reduced confidence
Inadequate/Missing/Delayed Feedback to Controller	· Lack of willing counterparties in financing markets

Table 4.4: BSC Control Loop Flaws

The Bear Stearns Companies, Inc

Safety Related Responsibilities

- Ensure solvency of Balance Sheet - Monitor liquidity of assets and available capital base relative to terms of liabilities to ensure that all current liabilities can be met given available assets - Establish and enforce acceptable levels of leverage - Diversify balance sheet to protect against market segment downturns
- Ensure market has accurate knowledge of health of the firm - Verify that financial reports given to investors are accurate and timely - Combat rumors and misinformation
- Protect shareholder interests
- Ensure employees act in best interest of firm - Structure employee compensation in a way that will promote firm's interests

Context

- BSC had experienced huge success and profit growth throughout the 1990s and early 2000s
- Market had high demand for MBS backed assets, BSC had long been a leader in creating such assets
- High leverage and lots of MBS backed assets were "normal" for all big firms and considered necessary for competitiveness
- Complex financial instruments based on complicated algorithms were "normal" and considered necessary for competitiveness
- Employees excelled not through dedication and hard work, but sheer intelligence and risky trades - Human capital was very mobile between firms - Compensation packages were primary tool to retain "good" employees
- Firm met all regulatory requirements set forth by SEC, including capital base of $18 billion
- Firm and MBS securities it syndicated always had expected credit ratings
- Certain types of assets were considered to be "like cash" and assumed to be acceptable collateral

Unsafe Decisions/Control Actions

- Allowed over-exposure to MBS related assets to accumulate on balance sheet
- Set funding strategy that relied heavily on short-term repo market
- Asked for resignation of employee who best understood the MBS market (Spector) as soon as trouble started
- Did not have policy/plan for quickly unwinding troubled positions during a run on the bank scenario

Process Model Flaws

- Assumed that prices and credit ratings were more stable than they were
- Assumed that initial trouble could be solved by firing employees involved
- Believed assets accepted as collateral today would again be accepted tomorrow
- Believed employee compensation scheme would ensure employees acted in interest of the firm, and that acting in the interest of the firm would inherently avoid risk
- Treated repo market as if it were a "lender of last resort" instead of a free market

Table 4.5: High Level Analysis of BSC

Market Counterparties

Safety Related Responsibilities

- Understand composition of financial instruments being traded on market
- Determine fair market prices of financial instruments
- Fulfill contractual obligations

Context

- Many new types of investment with higher yield-to-riskiness ratio that traditional "safe" investments
- All market participants rely on small number of federally designated rating agencies
- Computer-based risk models highly trusted and widely used in making investment decisions
- Early hits from slowing housing market—such as failed hedge funds—worry investors
- Expectation that media rumors have some basis in truth
- Uncertainty about systemic importance of a single institution
- Relatively small number of money managers in charge of vast sums of other people's money - Need to demonstrate "above average" returns to maintain control over investment pools

Unsafe Decisions/Control Actions

- Investors directly exposed to BSC begin to withdraw funds in response to media rumors, instigate run on the bank[5]
- Investors agree to purchase or trade instruments that they don't fully understand
- Investors accept high yields without questioning the source or sustainability of those yields

Process Model Flaws

- Market conditions will not change suddenly and dramatically
- Market creates high demand for MBS related instruments, believing that home prices can not fall
- Investors believe that they understand instruments they are exposed to
- Investors believe they are "hedged" (safe) by following complex strategies often based on computer models
- Some investors do not even know they are investors (unaware of investment strategy of funds where they have significant assets)

Table 4.6: High Level Analysis of Market Counterparties

Federal Regulators – Investment Banks

Safety Related Responsibilities

- Ensure banks are free of fraud or deceitful practices
- Ensure banks are following basic practices to protect customers
- Ensure adequate mechanisms for public knowledge of investments - Ensure investors have access to adequate knowledge of risks - Conduct audits of bank practices - Monitor markets
- Ensure that national economy is safe - Monitor inter-connectedness of financial system - Ensure that all institutions and instruments are properly regulated - Protect federal resources
- Detect and eliminate market externalities that arise in rapidly changing markets

Context

- Complicated regulatory schema (Fed, SEC, FDIC, US Treasury, etc) with different jurisdictions
- Political pressure for a "laissez-faire" economic policy
- Commercial banks seen as "safe" (given FDIC and Fed regulations) while investment banks were for more savvy investors with greater risk appetite
- Growing political and social power of banks, who generally support easing regulation
- Vast differences in compensation between regulators and those they regulate
- Rapidly changing market (new technologies, new instruments, new connections) very difficult for regulators to keep up with
- Banks constantly looking for (and finding) regulatory loopholes
- Political pressure to encourage home ownership in 1990s and 2000s

Unsafe Decisions/Control Actions

- Allowed regulatory distinction between commercial and investment banks to erode without a corresponding change to regulatory protections for both institutional types
- Did not distinguish between health of system and health of bankers/shareholders within system
- Allowed interconnectedness between regulated and unregulated entities to build
- Did not ensure there was an unbiased (not paid for by banks) credit rating mechanism
- Did not update regulatory requirements for investment bank balance sheet quickly enough
- Promoted housing policies that led to unsafe mortgages
- Did not require disclosure from independent credit rating agencies on operations

Process Model Flaws

- Financial institutions would "self-regulate" in order to stay competitive
- Failure of un- and lightly- regulated entities would only impact investors directly exposed to them
- MBS instruments were created safely, reflecting accurate risk profiles to investors
- Failure of single institution or instrument would not impact entire financial system

Table 4.7: High Level Analysis of Federal Regulators

Chapter 5 Discussion, Recommendations and Conclusions

"These things do occur with some regularity, and we haven't ever figured out how to stop the next one from happening. I'm sure we'll figure out how to prevent something like this from happening again. Wall Street is always good at fighting the last war. But these things happen and they're big, and when they happen everybody tries to look at what happened in the previous months to find someone or something to blame it on. But, in truth, it was a team effort. We all [messed] up. Government. Rating agencies. Wall Street. Commercial banks. Regulators. Investors. Everybody."

-BSC CEO Alan Schwartz, speaking about Financial Crises [4]

Performing a CAST analysis enhances accident investigations by providing a systematic top-down methodology for looking at accidents, instead of the traditional bottom-up approaches. While CAST was developed with physical, engineered systems in mind, it is directly applicable to social systems as well. This chapter examines some of the hurdles encountered in the process of applying CAST to a socio-technical system, including major assumptions and difficulties. Next, there is a discussion of the results and the recommendations that stem from them. Finally, there is a comparison of the CAST analysis with the closest thing to an accident analysis that the federal government conducted—the Financial Crisis Inquiry Commission's (FCIC) Official Report and the chapter that concerns The Bear Stearns Companies, Inc.

5.1 Difficulties of CAST application to a Social System

Adapting CAST to an accident without a concrete underlying physical process was by far one of the largest difficulties with this analysis. Fortunately, the financial sector has always heavily organized itself around mathematical constructs, which meant that

the fundamental accounting equation Assets = Liabilities + Capital could stand in as a physical process, allowing for the completion of the analysis.

Grouping various actors into generic groups (i.e. treating BSC as a single entity instead of several business units within a hierarchy, grouping all federal regulators into a single group, and treating the market itself as a controller) was also necessary to complete the analysis, largely due to the lack of concrete information about how control loops really worked within these components. Because I could make reasonable generic assumptions about each of these groups, e.g. market participants will act in self interest, regulatory agencies cannot compete with Wall Street salaries, etc., the grouping was not detrimental to this initial attempt to apply CAST to a social system. However, I would like to again point out that the analysis could only be improved if it had all the resources and access behind it of the FCIC investigation.

Finally, the problem of how to treat the prevalence and importance of rumor and suggestion in the financial world demanded the necessity of some assumptions. As many commentators have suggested, financial markets are especially susceptible to self-fulfilling prophecies. Rumors may have the potential to lead to hazardous scenarios in physical systems (e.g. if an operator has an incorrect mental model based on a rumor), but no matter how many people believe there is a crack in a dam, the dam is whole unless there actually is a crack. However, a bank may be perfectly safe, but if enough customers believe it to be in danger, there will be a run on the bank and the bank's safety will suffer. In this way, a process that is fundamentally uncontrollable—wagging tongues—takes on a pivotal control role within the system. The importance of opinions and rumors in the market is tacitly accepted, but becomes exceptionally clear in the high-level control structure where we see that all direct influence on the balance sheet goes through the market and that very few specific entities have the capacity to exert any control whatsoever on the market itself.

This difficulty with the market's very important role in the system was addressed in the decision to treat the market as a controller despite the fact that it is really more of a simultaneous actuator/sensor. However, this analysis raises a new question for the field: if there are other examples of simultaneous actuator/sensors how should

they be systematically dealt with and appropriately analyzed?

5.1 lists the three major assumptions described above.

Assumption	Justification
Basic balance sheet equation (Assets = Liabilities + Capital) can stand as a proxy for a physical system during the CAST analysis	The CAST analysis relies on a physical system that is subject to control, both direct and indirect. A balanced balance sheet can serve as a physical system because it is based on mathematics. Thus, control can be exerted on inputs but the fundamental nature of the equation—whether or not the sheet is balanced—obeys natural laws.
Controllers can be grouped generically (i.e. all of BSC as opposed to different units, all federal regulators as opposed to SEC vs Federal Reserve, etc)	Due to lack of knowledge about practices of BSC and its regulators, any piece of this analysis attempting to assign how different BSC business units interact or different policies of regulatory agencies would be guesswork. To avoid micro assumptions clouding the analysis, I am making this macro assumption.
"The Market" can be treated as a controller	Because The Market acts as both actuator and sensor for BSC control over its own balance sheet, it occupies a unique place in the control loop. Additionally, because The Market is comprised of many different entities all with essentially the same goal of maximizing personal profit, it does exert some influence. Finally, the importance of rumor in outcomes implies the market is a controller, even if only indirectly.

Table 5.1: Major Assumptions of BSC CAST Analysis

5.2 CAST Review and Recommendations

By far the most important factor during the CAST analysis of the BSC collapse is the extreme importance that the market plays on a firm's ability to control its balance sheet. While this statement might seem obvious to financial professionals, it has profound implications for what is necessary to keep both a single institution and the entire economy "safe." Many of the contextual assumptions that the controllers—both BSC employees, and their regulators—made prior to the accident revolved around things that the market would or would not always do. Things like "housing prices will never

fall," "certain types of asset will always be accepted as collateral in the repo market," "we will have time to unwind highly leveraged positions when we start to see prices falling," and "the failure of a single intuition is something the market can absorb" all assume that "The Market" will obey certain rules. Essentially these assumptions assume that the market is subject to a kind of self-control. One could hypothesize that BSC executives did not truly understand the company's own high level safety control structure (4-1), and did not account for the fact that no BSC employee had direct control over the balance sheet without going through the market and therefore suffering its whims. No BSC employee explicitly observed that the market controlled their balance sheet more than they did until after it was too late. At that point, the general observation was along the lines of there was nothing we could have done. This thesis argues that the mere act of realizing that the market had such control and that the market itself was controlled by other entities (media[1], rating agencies, regulators, and its own participants) might have created more caution in BSC traders who hubristically assumed that they had direct control of their balance sheet. After all, even the Mona Lisa is worthless if no one is willing to pay for it—a fact BSC and its regulators quickly discovered during March 2008.

This "intermediary" role that the market played can also be seen in its simultaneous role as actuator and sensor over the balance sheet. This simultaneous responsibility had profound impacts on BSC's ability to quickly perform the tasks necessary to avoid a hazardous state. Because the market was a simultaneous actuator/sensor, the "actuator" role it needed to play in buying, selling, pricing, and providing funding was already compromised as soon as the "sensor" role had been fulfilled. Put simply, BSC relied on the market to indicate when the balance sheet was in trouble, but failed to account for the fact that once the market itself knows about the trouble, it is that much more unwilling to engage in its "actuator" role. Could BSC (or its

[1]It is interesting to observe to what degree the media is an "island" within the control structure. It gets information from market participants and exerts heavy influence on the same, but does not have any other obvious or direct control connections. If BSC had created a control structure prior to the accident and observed the unique position of the media, could they have developed some sort of new control mechanism to directly impact the media in a way that might have helped them come March 2008?

regulators) have done anything about this, or is it just a fundamental trait of a free market? It certainly is acceptable to believe that "the market has a mind of its own," but it is also the case that the concept of portfolio diversification has existed for decades, precisely because of the role of the market in this capacity. And yet BSC convinced itself and its regulators that it was properly hedged against its exposure to the MBS market. However, a large part of this diversification strategy relied on exposure to different types of instruments within the same MBS market. If we were to draw another control structure that further segmented the market—into the repo market, the common stock market, the CDO market—and create BSC control lines of varying intensities (to reflect dollar value of exposure in that market) to the balance sheet, we might see that BSC was not as diversified as they believed, but instead was relying on various markets more than others.

Finally, we can begin to draw conclusions about employee motivations from the control mechanisms. We see that the BSC employees closest to the balance sheet are those within the Capital Markets Unit (CMU), that is, firm traders who are making decisions about the relative composition of firm assets and liabilities. The CMU exerts all of its control on the balance sheet through market mechanisms, but the path for corresponding market mechanisms to control the CMU traders (such as feedback to their higher-level controllers) is cumbersome. To some extent, BSC shareholders have control mechanisms over the executive committee and thus the CEO and thus the CMU, but this is not a direct line of control. This means that positive gains to the firm balance sheet can be easily claimed by the employees responsible and therefore rewarded. However, any losses to the balance sheet will not be claimed by employees and any negative feedback will have to work its way from the shareholders, through the executive committee, through the CEO, through the business unit to specific employees. While this analysis does not directly discuss employee compensation schemes, part of the general public outrage over Wall Street compensation is tied to this disparity between positive and negative compensation pressures on employees. The control structure helps to illuminate why it exists.

Finally, the organization of regulatory pressures bears some discussion. This anal-

ysis purposely left out some of the agencies that BSC would have interacted with and for the sake of clarity focused on the primary regulators (see Appendix B - US Financial Regulatory Agencies for descriptions of other regulatory bodies). One thing that is immediately clear in this limited analysis is the difficulties in coordination between a number of regulatory bodies operating on different segments in the same industry. Jurisdictional issues between the SEC, the Treasury and the Federal Reserve can easily arise in a system with multiple regulators, including loopholes. While BSC was primarily regulated by the SEC, it is unclear who regulated many of its subsidiaries in the so called "shadow banking system." The inability to define a single "top" for a top-down analysis such as this suggests an immediate flaw in the system, and a need for a single macro regulatory body.

The conceptual difference between the regulatory role in this case and what a similar analysis of a commercial bank might look like also bears mentioning. Commercial banks are subject to Federal Reserve regulation and FDIC regulation, but they have the benefit of the "lender of last resort" and insurance guarantee functions of those two bodies, respectively. A control structure for JPMorgan, the firm that ended up purchasing BSC might look very similar, but it would have a level of control on the market that BSC did not, namely, the presence of federal backing to prevent a run on the bank. While these functions are certainly not foolproof, they do provide drastically increased stability to the commercial banking sector. Indeed, the fact that all of the major investment banks that did not fail were either merged or acquired by commercial banks demonstrates the relative stability of these institutions within identical market conditions. The fact that the government did intervene with BSC before it could declare bankruptcy indicates that regulatory authorities were aware of damage that failure of a single institution could cause, but had opted not to create specific regulatory plans to account for it. Had that regulatory "wall" of guarantees existed prior to March 11, BSC might not have come so near the brink.

5.2.1 Primary Causes of the Accident

Based on the CAST analysis, the primary systemic causes of the BSC accident are:

1. BSC decision makers implicitly trusted in the market not to change its behavior, and subsequently failed to plan for drastically changed market conditions.
2. BSC decision makers believed diversification within a single market was sufficient for safety, but failed to diversify across different markets.
3. BSC employees get credit for positive returns, but are not held accountable for negative returns.
4. The regulatory schema was complicated and non-compact within the financial industry.
5. Too much regulatory attention was centered on maintaining nominally healthy balance sheets, instead of overall market safety.
6. Regulators did not ensure that there was an unbiased source of information on credit ratings of institutions and securities.
7. Regulators did not distinguish between the health of the economy and the health of individual banks.

5.2.2 Recommendations

Because this thesis focuses on regulatory and technological change in the financial sector, the recommendations will focus on regulatory measures. If firms performed a similar analysis, they may come up with important corporate changes as well. The recommendations that follow are my best thoughts on how to change the current regulatory system so as to avoid future accidents like the BSC collapse and the credit crunch of 2007-2008. With that in mind, they are recommendations that are meant to be attainable and practical.[2]

[2]It is tempting to recommend that we do away with the current financial system altogether and start from scratch with a better-engineered system, however this is neither attainable nor practical.

1. Regulation of the financial sector needs to be simplified, including the creation of a single regulatory oversight body for the financial sector.
2. The regulatory oversight body needs to invest in understanding systemic complexity of financial system and provide appropriate regulations for a dynamically changing system.
3. Regulatory oversight should require that financial institutions perform their own periodic systems-theoretic safety/risk evaluations, including understanding their safety control structure and looking for weakness in it in either control or feedback functionalitites.
4. Regulatory oversight should cover compensation in that it ensures that both positive and negative market feedback are incorporated into specific compensation decisions. If this is impossible, compensation should be limited across the sector.[3]
5. Regulatory oversight should address not only the capital requirements (i.e. short-term assets) on a bank's balance sheet, but the mix of short and long term assets and liabilities as part of the firm's overall funding strategy and require firms to have contingency plans for the failure of any particular type of funding, for any reason.

[3]Limiting compensation is a controversial prospect. However, if positive and negative feedback cannot equally factor into compensation decisions, the system is fundamentally flawed. The argument that limiting compensation will drive talent into other firms or other industries is a weak one that is nevertheless moot given a blanket regulatory control over compensation.

5.3 Comparison of the CAST and FCIC Analyses

There is no official method for analyzing social accidents such as the financial crisis. The idea that engineering methodologies could serve as a template for better social analysis is not new, and the National Transportation Safety Bureau has been posed as a potential model for creating a sort of Financial Accident Investigation Bureau (Fielding, Lo, and Yang 2011). If such an institution were to exist, it could use scientifically motivated methods such as CAST to further its work. However, the current official model is to investigate accidents in the social sector via Congressional Committees.

In the case of the credit crisis of 2007-2008, the US Congress passed the Fraud Enforcement and Recovery Act in 2009 which created the Financial Crisis Inquiry Committee (FCIC). The FCIC was a panel composed of 10 private citizens who all had experience in various areas of the financial sector. As is often the case, the members were appointed by both sides of the aisle—six by the majority Democrats and four by the Republicans. The statutory obligations of the committee included investigating the crisis in general, but highlighted 22 specific topics (e.g. "fraud and abuse in the financial sector" or "compensation structures") as well as the "major" financial entities that failed or relied significantly on government intervention to avoid failure. BSC falls into this group. In 2001, the commission published its 500+ page report. Chapter 15 of this report, entitled "March 2008: The Fall of Bear Stearns" is the closest thing to an official accident report available, and will serve as a benchmark for the results of the CAST analysis.

The FCIC analysis of the Bear Stearns collapse starts just after the collapse of the hedge funds in 2007 (which had been described in a subsection of the earlier chapter of the report entitled "Early 2007: Spreading Subprime Worries") and chronologically covers the time until the Federal Reserve sponsored bailout. The analysis reads somewhat like a novel or news story, relying heavily on quotations from the hearings the FCIC conducted. The report also suffers from significant hindsight bias[4] and often

[4]Hindsight bias is described by Leveson as playing an important and often detrimental roll in accident analysis [19]. Hindsight bias occurs when the benefit of hindsight is used to explain accident

focuses on the contributing factors that were most heavily covered in popular media without any scientific or academic discussion of how those factors actually came into play in the accident.

For example, in the midst of discussing BSCs losses over the course of 2007, the report begins a discussion of executive compensation, without any explicit context for why compensation is relevant:

> "For 2007, even with its losses, Bear Stearns paid out 58% of revenues in compensation... Warren Spector, the co-president responsible for overseeing the two hedge funds that had failed, received more than $98 million during the same period. Although Spector was asked to resign, Bear never asked him to return any money." [10]

Passages such as this can be found throughout the FCIC report. They are problematic for many of the reasons that traditional accident investigations are often problematic. First, the report offers no context for its tacit disdain of executive compensation packages—for example, why these type of packages have evolved in publically owned companies, or details of the CAP program (discussed in this analysis in Chapter 3) that provided such high compensation to Mr. Spector, or the legality of claw-backs on executive compensation. Secondly, the report attempts to highlight "villains" that can serve as scapegoats, a strategy that does nothing to seek to avoid future crises, as it is a fair assumption that there will always be executives seeking to grow their compensation. A safer financial system should not hinge on a sudden lack of greed from executives. Finally, the FCIC is more of a subjective narration of events without a concrete discussion of how the investigators created their conclusions. 5.2 shows the problematic FCIC conclusions in their entirety: there are no other recommendations or explicit discussions of how these conclusions were determined.

These conclusions are very typical of a subjective bottom-up approach to accident analysis. Because the goals and methodologies of such an investigation vary dramat-

causality: it is easy to say what should have been done by an operator when we already know what was not done.

The Commission concludes the failure of Bear Stearns and its resulting government-assisted rescue were caused by its exposure to risky mortgage assets, its reliance on short-term funding, and its high leverage. These were a result of weak corporate governance and risk management. Its executive and employee compensation system was based largely on return on equity, creating incentives to use excessive leverage and to focus on short-term gains such as annual growth goals. Bear experienced runs by repo lenders, hedge fund customers, and derivatives counterparties and was rescued by a government-assisted purchase by JP Morgan because the government considered it too interconnected to fail. Bear's failure was in part a result of inadequate supervision by the Securities and Exchange Commission, which did not restrict its risky activities and which allowed undue leverage and insufficient liquidity.

Table 5.2: FCIC Conclusions

ically to those of the top-down objective CAST analysis, it is useful to compare the results in so much as such a comparison is possible. If we attempt to deconstruct the FCIC conclusions into simple causes we see that the FCIC report essentially identified the major immediate and long-term causes of failure and highlighted the effects of a compensation structure based on "return on equity." [5] 5.3 presents a side-by-side comparison of the basic points from the FCIC conclusions and the CAST conclusions. Because the FCIC report does not make any policy recommendations based solely on the Bear Stearns case, there is no way to compare recommendations. However, the "causes" identified in the FCIC report are more descriptions of common market factors and do not lend themselves to easily be translated into recommendations on how to handle such factors and to prevent similar events in the future.

[5]Note that the FCIC report states that compensation is based on returns on equity but does not discuss what this means nor does it delve into the Bear CAP program (discussed in Chapter 3), nor provide any context within this chapter on typical compensation practices or theories.

Accident Factors	FCIC	CAST
Immediate Cause of Failure	· Exposure to risky mortgage assets · Reliance on short-term funding · High leverage · Bank runs (repo lenders, hedge fund customers, derivatives counterparties	· Market role as actuator and sensor meant that a distressed market was unable to act · BSC did not have plans for a rapidly changing market scenario
Long-term cause of failure	· Weak corporate governance · Weak risk management · Weak supervision by SEC	· No long-term understanding of systemic role of BSC by employees or regulators · Regulators did not provide a "emergency wall" between market and balance sheet
Impact of compensation structure's focus on equity return	· Incentives to use leverage · Focus on short-term gains	· Positive and negative market feedback not delivered to BSC employees through equivalent channels

Table 5.3: FCIC and CAST Results Comparison

5.4 Final Thoughts

The FCIC's website concludes its outline of the work it conducted with the statement "The Commission's hope is that readers can use its work to reach their own conclusions, even as the comprehensive historical record of this crisis continues to be written." ("About the FCIC," 2012) While any analysis—including this one!—hopes that the reader will draw their own conclusions, the application of the CAST methodology tries to demonstrate that the analysis of social system "accidents" need not involve wholly subjective, bottom-up or chain-of-events based analysis. Through the application of a systems-theory based methodology, this thesis has sought to demonstrate that social system analysis can be more rigorous and more objective than the current narrative-based methodologies allow.

The goal of this work was to demonstrate such a top-down, control-theory based analysis and to show how conclusions about social accidents such as the collapse of investment bank Bear Stearns can be systematically, rather than subjectively, arrived at. While the conclusions of this analysis are not necessarily novel—there is such a wealth of academics, industry professions, media sources and political pundits who have ventured to analyze this incident that most cogent points about the fall of BSC have already been made—the hope is that similar analysis of other, less publically vetted accidents conducted by analysts with direct, comprehensive knowledge of the incidents might illuminate systemic factors in time for regulators to take action, rather than merely decrying them with the benefit of hindsight.

Appendix

A Financial Products and Definitions

Asset Backed Securities (ABS)/Mortgage Backed Securities (MBS)

Asset Backed Securities are financial instruments that represent the value of an underlying pool of assets. As opposed to a share of common stock, where the underlying asset is ownership in a specific legal entity, ABS are functionally equivalent to a share of ownership in a pool of underlying assets (which could be stocks, or pieces of consumer debt, or residential mortgages). Generally, the underlying assets have some sort of periodic income payments associated with them, which give the ABS its market value. Mortgage Backed Securities are a specific class of ABS that are backed with residential mortgages. An MBS is created when a syndicate or underwriter (often a large bank) purchases a large number of mortgages, pools them together, and then sells "shares" of the pool to many different investors. A share entitles its owner to some portion of the mortgage payments as they are made. Various shares will be prices to reflect the risk, which is usually tied to the order of repayment to shareholders. For example, if all of the mortgage holders make their monthly payments, everyone who owns an MBS share will be paid as well. But if some of the mortgage holders default, then the MBS holders who accepted the most risk (probably by paying the least for the MBS) will not receive income payments that month. Note that ownership in an ABS does not imply an ownership claim to the specific assets that back the security, but only to the expected income stream.

Commercial Paper

Firms can also issue commercial paper as a way to raise short-term capital to finance their day to day operations. Commercial paper is akin to a very short term bond: the firm will sell the promise of future repayment (with interest) to a creditor. This is akin to issuing an IOU to a friend or family member: where the amount of interest necessary to secure the loan is determined by the trustworthiness of the issuer. That is, if I ask to borrow $100 and give you an IOU (i.e my commercial

paper) for a week from now, if you think I am very trustworthy you might accept an IOU for $101, but if you do not trust me to have your money you might demand that I pay $110 in a week.

Derivatives

Derivatives are a type of financial instrument that specifies conditions of payment. Often, derivatives are pegged to specific market conditions occurring, and if those conditions occur, one party is legal obligated to fulfill the terms of the derivative. Derivatives can, by definition, be derived off of a wide range of market conditions, but they are often tied to price or credit events. For example, Credit Default Obligations (CDO) are a common derivative that basically serve as an insurance contract in the case of a credit event. The CDO issuer promises to pay if and when a specific company fails to meet their credit obligations. In this way, a counterparty who is exposed to Company A can hedge their exposure by purchasing a CDO to cover the loss in the event of a default by A. Many derivatives are very simple: one counterparty agrees to pay a certain price on a specific date in the future for a certain good, no matter what the market price for that good actual is.

Fair-Value Accounting

Fair-Value accounting refers to the practice known as "marking to market" or determining the current market value of an asset. This practice is contentious as many assets may have a low present value but in the long-run be worth significantly more. For example, if I own a bond for company X and am forced to sell it on the day that company X suffers from a major negative new story; I may be selling it for much less than it will sell for just a few days later, when the negative press has dissipated. For this reason if you were to ask me on the day of the bad press what that bond were worth, I might be tempted to tell you that it is worth more than the market price at that moment—because I know that yesterday and every day before yesterday it was worth more and I believe that this negative press is not accurate and will not

affect the long-term value of that bond. If you force me to value it based on the price in the market at that moment, you are asking that I mark to market. Another example: if I purchased my home a year ago for $100,000 and you tell me that I must mark-to-market that home today, I will be at the mercy of the buyers I can find. If I can only find one person willing to buy the home, and that person will not pay more than $30,000 for it, I will be forced into a significant loss of wealth (even if I don't actually sell to that person) that does not necessarily reflect the actual value of the home—even if no one wants that exact home, I may be able to raze it and sell all the appliances and the land for a sum of $70,000—making the $30,000 and inaccurate mark-to-market value of the asset.

Options

Options are a specific type of derivative that give the owner the right to buy or sell a particular financial asset at a particular price. An option will specify a date or date range when the owner may buy or sell asset X from the issuer at a specific price. Note that options are not obligations—the owner of the option does not have to buy or sell at the specified price if they prefer not to.

Repurchase Agreement (Repo)

A repurchase agreement or repo occurs when two institutions agree to a short term sale: cash for collateral, to be repurchased at an agreed upon later date—in effect, a short-term collateralized loan. For instance, Bank A will agree to purchase $100 worth of Asset X from Bank B for $98 (the difference in price is the "haircut," and part of the reason Bank A is willing to agree to the repo). Bank B agrees to repurchase the position of Asset A back from Bank A at a later date (usually the next day). This transaction allows Bank B to use its assets as a source of short-term funding and allows Bank A to make a little bit of profit. Another version, a third party repo, occurs when the repo engages a third party to hold onto the collateral: I will give my ipod to our mutual friend who will hold it for you until I pay you back.

B US Financial Regulatory Agencies

Commodities Futures Trading Commission

An independent agency created by Congress in 1974 to regulate futures options and commodity markets in the US and protect against "fraud, manipulation, abusive practices and systemic risk" in the derivatives market.

Website: http://www.cftc.gov

Financial Industry Regulator Authority

The largest private regulator for securities firms in the US (self-regulatory organization) and the replacement for the National Association of Securities Dealers (NASD). Ensures that securities dealers are licensed, that securities are advertised truthfully and sold to suitable investors and that investors receive appropriate disclosure about investment products. FINRA can fine, suspend or expel both firms and individual brokers who have violated regulations within member organizations. FINRA is funded by assessment fess, membership dues and fines levied.

Website: http://www.finra.org

Federal Reserve System

The Federal Reserve is the central bank (created in 1913 by the Federal Reserve Act). The Board of the Fed consists of seven members who oversee the 12 reserve banks (located in different geographic districts) and set monetary policy for the nation. Monetary Policy consists of the action the central bank can take to influence the interest rate—that is the cost and availability of money for investment. The Fed has three main monetary policy strategies. First are open market operations, or the buying and selling of US treasuries on the market, which effectively makes the money supply larger or smaller, and thus the cost of borrowing money relatively larger or smaller. The Fed can also set the Discount Rate—the rate charged to institutions for

borrowing money from the Fed. Finally, the Fed can set the Reserve Requirement—the amount of funds that banking institutions must hold against deposits.

Website: http://www.federalreserve.gov

Federal Deposit Insurance Corporation

A government corporation (created in 1933 by the Glass-Steagall Act) and provides deposit insurance for member banks. The FDIC also does some amount of oversight for member banks (including various consumer-protection efforts) and manages banks that have failed. The FDIC only insures deposits, and does not insure investments. The FDIC examines banks for compliance with various consumer protection regulations and general safety/soundness of banking practices. The FDIC is funded by premiums that member institutions pay for deposit protection and from investment income (US Treasuries).

Website: http://www.fdic.gov

Office of the Comptroller of the Currency

An independent bureau of the Department of Treasury (established in 1863) serves to "charter regulate, and supervise" national banks and savings associations. The Comptroller is also the director of the FDIC. The OCC can examine institutions that it has chartered, grant new charters (or branches), supervise institutions that do not comply with regulations (including removing officers), and issue rules and regulations about investment practices. The OCC is not funded via taxpayer dollars, but instead by payments from member institutions, through examination fees and processing fees. The OCC also has some investment income (US Treasuries).

Website: http://www.occ.treas.gov

Office of Thrift Supervision

Supervises savings associations and their parent corporations to ensure consumer protection, created in 1989 from the Federal Home Loan Bank Board (after saving & loan crisis). The OTS was funded by the institutions that they regulate. As of summer 2011, this responsibility was transferred to the OCC.

Website: http://www.ots.treas.gov

Securities and Exchange Commission

Created by the Securities Act of 1933 and the Securities Exchange Act of 1934, the SEC protects investors and strives to "maintain fair, orderly, and efficient markets." The SEC largely accomplishes investor protection through requirements on public companies to disclose certain data about performance and standing, including overseeing the process of officially registering securities. The SEC also has the authority to enforce (via civil enforcement actions) securities law and regulations. The SEC interprets federal securities law as well as issue new rules and regulations (including amendments to existing rules). The SEC is funded thru congressional appropriations.

Website: http://www.sec.gov

State Regulators

In addition to all of the federal regulators, each state had its own regulatory scheme for banks, insurance and securities. These state regulators could vary widely state to state in their scope and power, and the severity of state-level regulations played a large part in where companies chose to incorporate themselves.

Website: http://www.nasaa.org

United States Department of Treasury

The US Department of the Treasury is an executive agency concerned with the general condition and financial safety of the US economy as a whole. Its mission is to "maintain and strong economy and create economic and job opportunities by promoting the conditions that enable economic growth and stability at home and abroad." Its primary responsibilities are to manage the federal coffers, including collecting taxes and debts owed to the US government and issuing currency. It is also responsible for supervising national banks. The Dept of Treasury can also expand its statutory obligation to promote the safety of the US economy as justification for involvement in any number of potential threats to the financial system.

Website: http://www.treasury.gov

C Bear Stearns Lines of Business

The various lines of business that BSC engaged in at the time of its sale are outlined in 3-1 on page 55. Below is a brief description of what each line of business might have done, but as there is no official description of these businesses, this is based on best guesses.

1. **Capital Markets**

   The portion of BSC that directly links people with capital to invest with people who need a capital infusion. This arm of the business will also conduct all of the firm proprietary trading—the trades that directly impact what is on the firm's balance sheet.

   (a) Equities – The unit that deals with equity securities, or stock (ownership shares).

   (b) Fixed Income – The unit that deals with fixed income securities, or bonds (debt).

   (c) Investment Banking – The unit that acts as middleman for deals.

2. **Global Clearing Services**

   The clearing house portion of the bank. A clearing house is an entity that essentially does all of the back office work to make sure that financial trades "settle" or occur as contractually specified. In some ways, the clearing service is a position of trust—because two parties in a financial transaction may not trust each other to fulfill the details of the trade, a trusted clearinghouse can act as a temporary buyer/seller to each side so that they do not directly face each other.

   (a) Trade Execution – Provides the actual execution of trades, the physical or virtual transferring of money and/or assets.

(b) Securities Clearing – Provides clearing services.

(c) Custody – Holds customer assets in custody (most likely for regulatory purposes).

(d) Financing – Loans capital to customers so that they can buy on margin.

(e) Securities Lending – Lends firm or customer securities to counterparties for a fee (a way to make money on securities that would otherwise just "sit" in the account).

(f) Technology Applications – Develop technological tools for all of the needs of the business unit.

3. **Wealth Management**

The Wealth Management provides investment and financial advice to wealthy clients.

(a) Private Client Services – Provide private investment advice to wealthy clients.

(b) Asset Management – Actively manage the assets of wealthy clients.

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