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The Lehman Brothers Bankruptcy H: The Global Contagion

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Abstract

When Lehman Brothers filed for bankruptcy on September 15, 2008, it was the largest such filing in U.S. history and a huge shock to the world's financial markets, which were already stressed from the deflated housing bubble and questions about subprime mortgages. Lehman was the fourth-largest U.S. investment bank with assets of $639 billion and its operations spread across the globe. Lehman's clients and counterparties began to disclose millions of dollars of potential losses as they accounted for their exposures. But the impact of Lehman's demise was felt well beyond its counterparties. Concern regarding its real estate assets, its large derivative book, and its significant involvement with collateralized debt obligations (CDOs)—a new type of security that incorporated subprime mortgages—soon "infected" the shadow banking system, contributing to a retraction of wholesale funding and a severe liquidity crisis for many firms, including many with no direct links to Lehman. In this case, we explore the concept of "financial contagion" and how a sudden shock to one firm, such as Lehman, can lead to other firms and markets experiencing similar impacts that are not totally explained by direct linkages.

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[1] This case study is one of eight Yale Program on Financial Stability (YPFS) case modules considering the Lehman Brothers Bankruptcy:

- The Lehman Brothers Bankruptcy A: Overview.
- The Lehman Brothers Bankruptcy B: Risk Limits and Stress Tests.
- The Lehman Brothers Bankruptcy C: Managing the Balance Sheet Through the Use of Repo 105.
- The Lehman Brothers Bankruptcy D: The Role of Ernst & Young.
- The Lehman Brothers Bankruptcy E: The Effects on Lehman's U.S. Broker-Dealer.
- The Lehman Brothers Bankruptcy F: Introduction to the ISDA Master Agreement.
- The Lehman Brothers Bankruptcy G: The Special Case of Derivatives.
- The Lehman Brothers Bankruptcy H: The Global Contagion.

Cases are available from the Journal of Financial Crises.

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1. Introduction

Lehman Brothers' filing for bankruptcy on September 15, 2008, was an incredible shock to the world's financial markets. Never before had such a large financial institution failed—its operations, clients and counterparties spread across the globe. Its derivative book alone consisted of more than 900,000 contracts. Lehman's clients and counterparties experienced direct effects from its failure and disclosed millions of dollars of potential losses as they began to account for their exposures, but that was only a small fraction of the impact. The tremors from Lehman's demise reached well beyond its direct counterparties. It was a signal that no bank was *too big to fail* and that, despite its earlier efforts on behalf of Bear Stearns and Fannie Mae and Freddie Mac, the U.S. government could not be counted on to step in to save every entity.

Lehman's bankruptcy occurred in the midst of a period of severe stress for the financial system. Beginning in mid-2007, as the housing bubble deflated, there was increasing concern about the value of subprime mortgages and related securities. This concern soon infected other types of securities and spread to the broader financial markets through the shadow banking system, causing a retraction of wholesale funding and a severe liquidity crisis. Ultimately, it was Lehman's inability to fund its highly leveraged operations that led to its demise. And that demise further destabilized the weakened markets, both within the U.S. and beyond. By the end of 2009, the U.S. government had invested $1 trillion to stabilize the economy, yet losses amounted to $11 trillion (FCIC Report xv).

In this module we explore the concept of "financial contagion." Defined in many ways, the term generally means a situation where one firm or market experiences a sudden shock that leads to other firms and markets experiencing a similar impact that is not totally explained by direct linkages. To fully understand how the subprime mortgage crisis and Lehman's bankruptcy infected the world's markets, we will also examine the widespread use of securities that incorporated subprime mortgages.

The remainder of this module is organized as follows: Section 2 defines financial contagion; Section 3 discusses how contagion is transmitted; Section 4 considers the policy implications regarding the different transmission methods; Section 5 discusses the subprime mortgage boom and the concurrent increase in securitization; Section 6 examines the subprime mortgage crisis and how it affected securitized bonds and the broader market; Section 7 explains Lehman's real estate strategy during 2006-2007 that led to its vulnerability to market stresses and the broad impacts of its bankruptcy; and lastly, Appendix A presents a timeline of the major events of the financial crisis.

Questions

1. What is financial contagion?
2. What are the various channels by which contagion migrates among markets?
3. Are there situational elements that fuel or mitigate the spread of contagion?
4. How did the subprime mortgage crisis contribute to Lehman's demise?
5. Why was the impact of Lehman's bankruptcy so difficult to predict and contain?
6. What were the key factors that enabled the contagion to spread beyond the U.S.?
7. What are the policy implications of a contagion's impact on markets?

2. Understanding Financial Contagion

What is Financial Contagion?

Since the financial crisis, much research has focused on financial contagion to explain the gravity and breadth of the crisis. Originally borrowed from epidemiology, the concept of "contagion" means "the transmission of a disease by direct or indirect contact" (Merriam Webster). Financial contagion theory grew out of the research on financial panics, bank runs, and herding behavior.

Despite the significant volume of research, there is not yet any one definition of "financial contagion." Instead, researchers have developed multiple meanings that emphasize different elements. One useful framework posits that a contagion has three key elements:

> (1) an inciting incident or shock [to a market],
>
> (2) significant and negative effects that,
>
> (3) are also experienced by a second market.

Any number of financial incidents can become incidents or shocks that lead to contagion flowing to different markets. Historically, research concluded that a failure of one bank could lead to a run on other banks, even if the later ones were fundamentally sound. (See Gorton 2010 for a summary discussion of bank panics.) Later research focused on contagion between countries and/or regions (i.e., Asia and Latin America) and identified additional inciting incidents.

Contagion incidents have been known to happen from the failure or bankruptcy of a firm (Lehman Brothers), devaluation of a currency permitting a currency to float (Mexican crisis of 1994-95 and Asian crisis of 1997-98), a failure to pay sovereign bonds (Russian crisis of 1998), or external bank debt. Each of these types of incidents has led to sudden and unexpected upheavals in a key market, which then spread to other markets.

There is a general consensus that the global financial crisis of 2007-2009 began with the U.S. subprime mortgage crisis, which started mid-year 2007, and which precipitated a credit contraction in the shadow-banking market. This credit crisis was a critical factor in Lehman's filing for bankruptcy a year later. Each of the events can be seen as a precipitating shock, and thus, the crisis can be divided into two phases—the subprime crisis (pre-Lehman) and the period after Lehman's bankruptcy filing (post-Lehman). However, it was the connection between the two periods that was particularly devastating to the world's economies. The first shock (subprime mortgages infecting other types of securities) severely weakened the short-term credit markets and prompted investors to hoard liquidity. The second shock (the fear and uncertainty of unknown risks after Lehman), greatly exacerbated this already weakened situation and resulted in a severe liquidity crisis that spread throughout the world's markets.

Spillovers vs. Investor Behavior

Against the above general framework, researchers have looked at contagion in many ways. According to Dornbusch, "[c]ontagion is best described as a significant increase in cross-market linkages after a shock to an individual country (or group of countries)" (Dornbusch et al., 3). He discusses two major categories: spillovers and investor-directed behavior. Spillovers occur when shocks are transferred from country to country through real and fundamental linkages, the most basic of these being trade linkages, contracts, and political

linkages. This theory would explain the immediate effects of Lehman's bankruptcy as its counterparties accounted for direct exposures.

By contrast, investor-directed episodes of contagion cannot be linked to any real or fundamental interconnections but are the result of actions by investors or other financial agents as they react to the precipitating shock. Dornbusch cautions that, although such behavior may seem like irrational herd behavior, investors' actions may individually be rational. For example, investors may experience liquidity pressures after a shock and thus may sell off securities in another market (which is not directly impacted by the shock) to raise funds. Because assets held by banks tend to be illiquid, this sudden sale can lead to a run in the market for the second security. This behavior was seen in 2008 and 2009 when the retraction in credit caused firms to raise cash by selling off high-value assets, which negatively impacted the prices of these assets. (See discussion in Liquidity Channel/Coordination Contagion below.)

The impact of investor behavior in inciting a contagion is also recognized by Scott (2012): "Contagion denotes the process whereby the failure of one institution either causes the creditors of others to withdraw funding in a manner akin to a classic bank run or sets off a general panic leading debt markets to freeze. Indeed, contagion may not even start with the failure of a particular firm; for example there could be a run on European banks because funders fear that all such banks could be in trouble" (Ibid., 16). Similarly, "contagion can develop from a generalized fear of failure on the part of short-term creditors as much as it can represent an overt reaction to specific cases of real distress" (Ibid., 116).

Consistent with Scott's analysis, it could be questioned whether, in October 2007, it was the default of a structured investment vehicle investing in subprime mortgages (Rhinebridge Plc) owned by a small German industrial bank (IKB Deutsch Industriebank AG) that exacerbated the ongoing retraction of the interbank markets, or the manner in which many investors responded to that default despite having no direct connection to the entity involved. Similarly, Scott posits that the impact of Lehman's bankruptcy was so significant not because of Lehman's interconnectedness to other institutions but because "it added to overall panic that likely led to liquidity hoarding and contagious runs" (Scott 2012, 5).

The Role of Financial Linkages

Differing from Scott, Kaminsky, Reinhart, and Vegh (2003) conclude that financial linkages better explain transmission than do trade linkages or investor behavior/information transmissions. "Only if there is 'excess co-movement' in financial and economic variables across countries in response to a common shock do [these authors] consider it contagion" (Ibid., 55).

Kaminsky, Reinhart, and Vegh (2003) have also observed that there have been financial shocks that did not result in widespread contagion or a chain reaction among markets. In light of this, Kaminsky identifies three additional key factors that distinguish those cases where a shock incident becomes a contagion from where it does not:

(1) an abrupt reversal of capital inflows,

(2) the announcements that set off the contagion are a surprise to the markets, and

(3) affected markets shared a leveraged common creditor (Ibid., 54-5).

Importantly, Kaminsky would also limit the definition of contagion to incidents where, in the presence of these three elements, "there are significant *immediate* effects in a number of

countries following an event—that is when the consequences are *fast and furious* and evolve over a matter of hours or days" (Ibid., 55).

This argument was originally devised in the context of financial contagions among emerging markets that experienced a significant influx of foreign currency that suddenly stopped. Consider whether Kaminsky's factors hold up with respect to the 2007-2009 crisis in the United States. Since the early 2000s, the world had been experiencing a "global savings glut," due to heightened savings rates abroad and increased earnings from oil-rich countries. These investors eagerly bought U.S. treasury bills but still wanted other safe investments for their money. The U.S. housing market was perceived as safe, and the glut of available funding was largely responsible for the creation of AAA-rated securities such as CDOs to meet this market demand (discussed in Section 5 below) (Bernanke 2009, 3-5). When the housing prices stalled and the subprime crisis began, there was a sudden retraction of this inflow of funds.

Gentile and Giordano (2012) also regard both the timing and method of transmission as critical to defining a "pure contagion." As an antecedent, they emphasize that there are constant shocks (monsoonal effects) being transferred between markets because of randomness or normal interdependencies such as trade and financial relations (linkages). They stress that, in a case of "pure contagion," one should be able to not only identify a clear shift in market impacts when entering the crisis period and immediately thereafter, but should also be able to identify a change in the transmission process itself, before and after the shock (Ibid., 10-11).[4]

3. How Does a Contagion Spread?

The question of how a contagion spreads once it occurs is at the heart of contagion theory. Longstaff (2010) discusses three major theories of transmission that have been developed in the research:

(1) the correlated information channel,

(2) the liquidity channel, and

(3) the risk premium channel.

While the first two of these channels (correlated information channel and liquidity channel) focus on investor behavior, the latter (risk premium channel) concerns itself with fundamental linkages, and evidence an important dichotomy that persists in the research. There is a lack of consensus about which type of transmission is most significant. As discussed below, each type of transmission has policy implications for regulatory responses and preventative measures. It should also be noted that the researchers agree that most often more than one transmission channel will be present at any time. (See discussion of Risk Premium/Counterparty Contagion below.)

The 2010 Economic Report of the President (President's Report 2010) provides an accessible discussion of contagion using slightly different terminology: confidence

[4] Gentile and Giordano also provide a useful review of the development of research on financial contagion from its early more general definition to its current more refined state.

contagion, counterparty contagion, and coordination contagion (President's Report 2010, 170-74). (Figure 1 reconciles this terminology with the broader literature.)

Correlated Information Channel/Confidence Contagion

Dornbusch explains the *correlated information channel,* which posits that the failure of a firm leads investors to update their beliefs about other firms that share similar characteristics. This leads to financial distress of the other firms, even if they have no direct business relationship with the failed firm and even if they do not share the characteristics that precipitated the first firm's failure. This phenomenon is similar to classic bank-run theory.

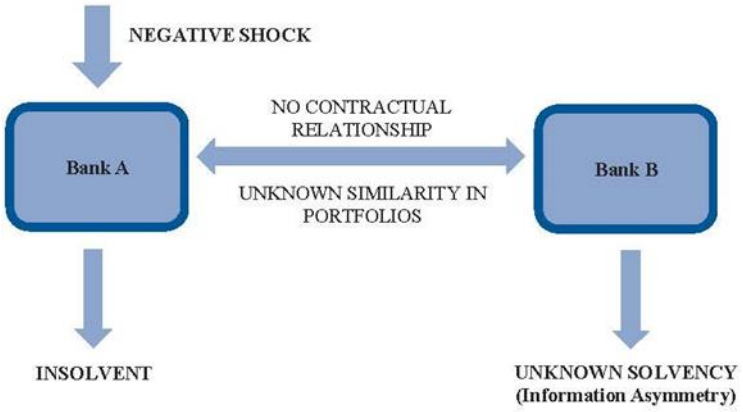
For example, if Bank A has a high preponderance of subprime loans and experiences heightened default rates as a result, its depositors may seek to withdraw their funds. Depositors of Bank B hear of the run on Bank A and, fearing the loss of their deposits, may also seek withdrawals. This may occur even though Bank B does not have an unusual exposure to subprime mortgages, or even to real estate (President's Report, 2010, 170-71). This phenomenon is illustrated in Figure 2.

Figure 1: How Contagion is Transmitted

Transmission Channel	Alternate Name	Description	Policy Implications/Remedial Response
Correlated Information Channel	Confidence Contagion	**Information-Based**: Negative information about one entity causes investors to withdraw from other entities with shared characteristics as confidence about the second entity erodes, based on the information about the first. Classic bank-run scenario.	Inject liquidity or capital or provide guarantees to restore confidence. Example: FDIC deposit guarantees.
Liquidity Channel	Coordination Contagion	**Information-Based:** Aggressive sales of assets by investors in a fire-sale environment depress several entities because they hold similar assets.	Inject liquidity into the market to stem the "run" or liquidity crisis. Example: Federal Reserve instituted several novel funding vehicles in 2008-2009, including the Primary Dealer Lending Facility and the Term Asset Lending Facility.
Risk Premium Channel	Counterparty Contagion	**Fundamental Linkages-Based**: Shocks in one market effect investors' willingness to bear any risk, and they withdraw from some markets and hoard funds.	Support the failing firm in an effort to reassure the investors and mitigate the spread of risk. Example: The Federal government stepped in to support AIG because collapse of its vast book of collateral default swaps (CDSs) would have negatively impacted most major financial institutions that held the CDSs and leave these institutions exposed.

Source: Longstaff (2010), Dornbusch (2000), and *President's Report (2010)*.

Figure 2: Confidence Contagion



Source: President's Report 2010.

Bank runs ceased in the U.S. after the Great Depression largely because of the adoption of FDIC depositor guarantees; however, the same phenomenon could easily be spurred in a nonbank context by the failure of an investment bank (Bear Stearns) or money market fund (Reserve Primary Fund).[5]

When in doubt about a firm's stability, it is easier for investors to abandon that firm rather than figure out its true situation. This might explain the severe dips in the stock prices of financial firms during the crisis and their lagging recovery, as shown in Figure 3. By early 2013, the S&P 500 was close to topping its 2007 record high. At the same time, the S&P 500 financial sector continued to lag by approximately 50% its all-time high, also reached in 2007.

Liquidity Channel/Coordination Contagion

The *liquidity channel* as explored by Longstaff (2010), states that "investors who suffer losses in one market may find their ability to obtain funding impaired, potentially leading to a downward spiral in overall market liquidity and other asset prices via a 'flight to quality'" (Ibid. 437). This phenomenon occurs when a firm needs to raise funds, but certain assets can only be sold at fire-sale prices. For example, Bank A owns Type I and Type II assets. An event occurs that causes a sudden major decrease in the value of Type I assets that threatens Bank A's solvency. To raise funds, Bank A sells its Type I and Type II assets. Because these assets may be illiquid and difficult to sell (as many bank assets often are), prices on the assets start to fall (President's Report 2010, 173).

Because Bank B also owns Type II assets, as well as Type III assets, it too begins to experience a decline in its portfolio, which may prompt regulators to require increased capital or a reduction in leverage (in the case of an investment bank, similar pressures may come from rating agencies). To meet these demands, Bank B begins to sell its Type II and Type III assets. In so doing, it also experiences depressed prices. As shown in Figure 4, this phenomenon can

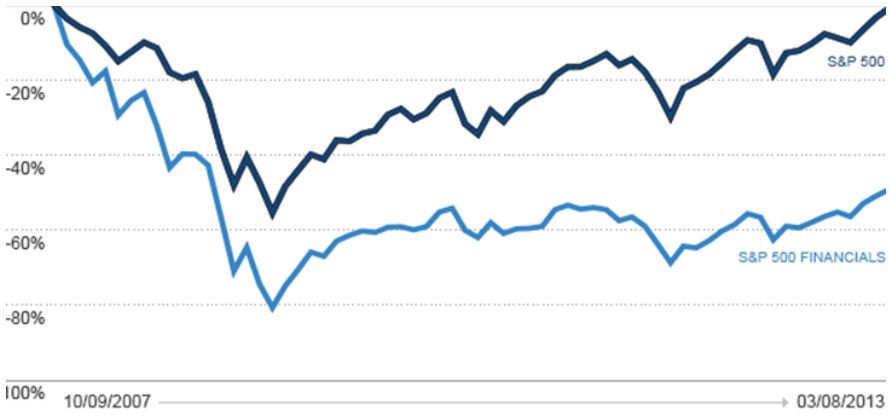
[5] On September 16, 2008, a day after Lehman filed for bankruptcy, the Reserve Primary Fund, a large money market mutual fund, lowered its share price below $1 because of its exposure to Lehman debt securities. This "breaking the buck" created a panic, since money market funds normally maintain a $1 net asset value. Investors clamored for their funds, and the fear was that investors of other MMFs would do the same.

continue throughout the spectrum of assets as firms seek to protect themselves, and it is exacerbated when firms have to liquidate assets quickly (Ibid., 173-74). It was in part fear of this cycle that caused Lehman to resist selling off its real estate portfolio; by mid-2007, the market for such assets had greatly declined.

Longstaff (2010) considers the effects of the subprime crisis by examining the correlations of the ABX index (a measure of daily closing values for subprime home-equity-related CDOs) with Treasury bond yields, corporate yield spreads, stock market returns and changes in the VIX volatility index (a measure of the implied volatility of S&P 500 index options). He concludes that the ABX index predicted the other markets and thus was indicative of contagion, which was propagated primarily through liquidity channels rather than through a correlated information channel.

Gorton and Metrick (2012B) use credit spreads for hundreds of securitized bonds to trace the path of the crisis from subprime housing-related assets into markets that had no connection to housing, such as the estimated $10 trillion sale and repurchase (repo) funding market (Ibid., 433). Securitized bonds, which often incorporate subprime assets, are often used as collateral for repos and investment banks, such as Lehman's reliance on repos for approximately half of its daily funding needs.[6] (See Wiggins, et al. 2014C for a detailed discussion of Lehman's use of a particular type of repo.)

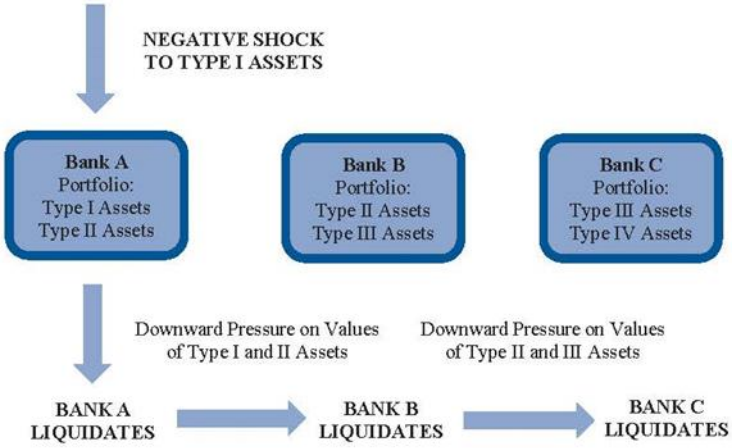
Figure 3: S&P 500 Indexes



Source: CNNMoneyInvest; Realtick.

[6] "Lehman funded itself through the short-term repo markets and had to borrow tens or hundreds of billions of dollars in those markets each day from counterparties to be able to open for business. Confidence was critical. The moment that repo counterparties were to lose confidence in Lehman and decline to roll over its daily funding, Lehman would be unable to fund itself and continue to operate.'' In 2008, Lehman was funding over $200 billion a day (Examiner's Report, Vol. 1, 3 and Fn 10).

Figure 4: Coordination Contagion



Source: President's Report 2010.

In another study, Gorton and Metrick found that changes in the LIB-OIS spread, a proxy for counterparty risk, were strongly correlated with changes in credit spreads and repo rates for securitized bonds, and indicative of counterparty contagion. Even before Lehman's failure, the overnight funding markets had begun to retract, impacting financial and even nonfinancial companies.[7]

Risk Premium Channel/Counterparty Contagion

The *risk premium channel* implies that a severe negative shock to one market may be associated with an increase in the risk premium in other markets that causes investors to be less willing to bear risk in any markets and prompts them to withdraw from some markets and hoard funds (Longstaff 2010, 437). This is most often spread through chains of counterparty linkages as illustrated by Figure 5 and discussed in the President's Report. Assume that Bank A owes $1 billion to Bank B, which in turn owes the same amount to Bank C. If Bank A becomes insolvent and cannot pay Bank B, then Bank B may not be able to pay Bank C, and so forth throughout the alphabet (President's Report 2010, 172). [8] Counterparty contagion is conceptually similar (and empirically indistinguishable) to the risk premium channel because, as some agents take losses from counterparties, their observed risk aversion would increase.

Counterparty chains such as these spread risks and contagion as risks shift. As noted by the President's Report, in the financial crisis, the widespread distribution of derivatives was a vehicle for contagion as the derivatives involved multiple counterparty chains. This conclusion was echoed by former Federal Reserve Chairman Bernanke in 2009—

[7] They also demonstrate that "the run was predominately driven by the flight of foreign financial institutions, domestic and off-shore hedge funds, and other unregulated cash pools."

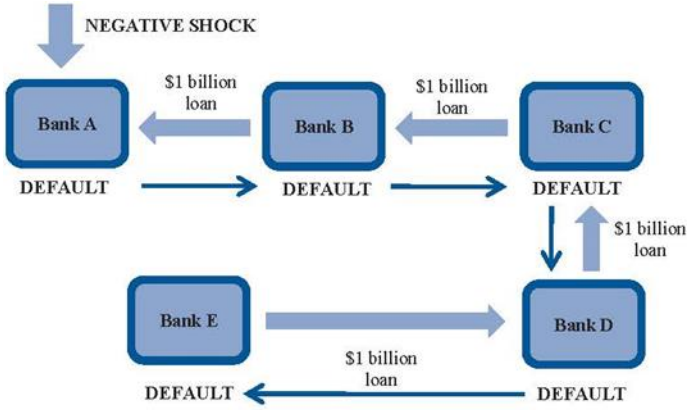
[8] Such counterparty chains, particularly with OTC derivatives, also have the potential for value destruction as each party that experiences a default may seize collateral and be compelled to dispose of it at less than optimal circumstances and value. To the contrary, if derivatives are cleared through exchanges, the exchange can net out the transactions, having only Bank A and Bank E in Figure 5 be negatively impacted.

"[O]bviously OTC derivatives were a problem. They may not have been a causal problem, but they transmitted stocks [sic]" (Ibid., 171). (See discussion in Section 5 below.)

Chakrabarty and Zhang (2012) discuss a mechanism for counterparty contagion (*counterparty risk channel)* which predicts that firms with identifiable financial exposure to the failed firm will suffer greater adverse consequences because of fundamental business linkages. Using information disclosed by companies after the Lehman bankruptcy, information from the bankruptcy filing and from other sources, they reviewed market liquidity, trading activity, information asymmetry, and order imbalance of companies. While there was evidence of information contagion, they found "robust support" for the impact of the counterparty risk channel and view this channel as more highly predictable than the correlated information channel.

Helwege and Zhang (2009) similarly tested the information and counterparty channels in the wake of the Lehman bankruptcy and also found a strong counterparty effect, especially for financial firms. They attribute this to the fact that the other financial firms shared similar business models and greater interconnectedness with Lehman. In light of these two findings, consider Federal Reserve Chairman Bernanke's statement to the Financial Crisis Inquiry Commission that at the height of the financial crisis, out of 13 of the most significant financial institutions in the country, "12 were at risk of failure within a period of a week or two" (Bernanke 2009, 24).

Figure 5: Counterparty Contagion



Source: President's Report 2010.

For more information see:

- Dornbusch, et al., *Contagion: How it Spreads and How it can be Stopped*
- Kaminsky, et al., *The Unholy Trinity of Financial Contagion*
- Longstaff, *The Subprime Credit Crisis and Contagion in the Financial Markets*
- Presidents Report 2010, and
- FCIC Interview of Ben Bernanke (2009).

4. Policy Implications

How one views contagion, its causes and migration, has significant impact for regulatory policy, both preventive and remedial. If the cause of the contagion is identified as being information-based, leading to a bank run or liquidity crisis, then a remedy would be to inject liquidity into the markets. This was the initial response of the Federal Reserve (the FED).

Beginning in the summer 2007, the FED instituted various programs to increase the available liquidity and combat the credit crisis that was even then spreading in the markets on the heels of the subprime mortgage crisis.[9] Its first efforts were to reduce the federal funds rate and discount rate. After the near failure of Bear Stearns in March 2008, largely because of an inability to fund its operations, the FED instituted new programs such as the Primary Dealer Credit Facility (PDCF)[10] to provide overnight funding and ease constriction in the repo market. After Lehman's collapse in September, the types of accepted collateral and the number of eligible borrowers were expanded.

In the weeks that followed, the FED instituted additional programs, and on October 14, 2008, the government announced a series of programs "to strengthen market stability, improve the strength of financial institutions, and enhance market liquidity." Funded by the Troubled Asset Relief Program (TARP)[11]—the law passed by Congress authorizing the injection up to $700 billion into the economy—these initiatives included the Capital Purchase Program (discussed below) and the Temporary Liquidity Guarantee Program (TLGP)[12] and were recognition that there was not one threat or solution to the growing crisis.

If it is perceived that the contagion is likely to spread through the risk premium channel/counterparty channel, supporting the failing institution is thought to be the best option, and several of the remedial actions taken by the U.S. government appear to follow this view.

On September 16, 2008, a day after Lehman's failure, the FED announced an $85 billion revolving credit facility for the insurance giant, American International Group (AIG), whose stock dropped by 60 percent at opening, following a downgrade the night before. A subsidiary of AIG, AIG Financial Products division, had aggressively sold credit default swaps (CDSs) on CDOs. A CDS is a type of insurance purchased to hedge against an investment's failure. At one point, AIG had a portfolio of $441 billion in CDSs, of which approximately $307 billion were transactions between AIG and banking organizations designed to assist the financial institutions in managing their regulatory capital requirements, and of which $57.8 billion were, with respect to CDOs and other structured debt, backed by subprime mortgages.

When subprime loans began to be downgraded, AIG's credit rating was downgraded, which led to collateral calls against its derivatives and severe liquidity problems. The risk of AIG's

[9] "From the second quarter of 2007 to the first quarter 2009, net repo financing provided to U.S. banks and broker-dealers fell by about $1.3 trillion—more than half of its pre-crisis total" (Gorton and Metrick 2012C, 1).

[10] See the website of the New York Fed for details regarding the PDCF: http://www.newyorkfed.org/markets/pdcf.html.

[11] See the FED website for a detailed description of the TARP: http://www.federalreserve.gov/bankinforeg/tarpinfo.htm.

[12] The TLGP was a series of initiatives by which the FDIC guaranteed in full all noninterest-bearing accounts and certain newly issued senior unsecured debt of banks. The efforts were aimed at calming the markets and encouraging lending. See the FDIC website at: https://www.fdic.gov/regulations/resources/TLGP/index.html.

failure meant that many of the world's largest financial institutions would have been exposed if AIG could not stand behind the CDSs that it had issued. Because of its many interconnections with the world's most significant financial companies, it was thought that AIG's collapse, especially at a time of tremendous market stress, would be catastrophic (Bernanke 2009, 26-7).

Beginning on October 28, 2008, the Treasury Department, through the Capital Purchase Program, injected $200 billion in capital directly into the major U.S. financial institutions, and hundreds of smaller ones to shore them up. A list of the banks and amounts can be seen here.

Preventing Contagion

Observers have argued that preventive measures could be taken to counteract contagion, making risk easier to identify and firms more able to withstand shocks. Three suggestions include:

> (1) Require enhanced liquidity and capitalization of firms so that they might better withstand a liquidity crisis.
>
> (2) Implement supervision that looks across the entire industry of financial firms and not just at insular parts of that industry (such as an individual bank or broker-dealer).
>
> (3) Institute a macroprudential regulator that looks across different institutions for systemic risks.

(See President's Report 2010 pages 174-180 and Anabtawi and Schwarcz (2001) at pages 1380-1402 for discussions of these points.) Provisions enacted as part of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) reflected all three of these points.

Another area where Dodd-Frank attempts to forestall future contagion is with respect to derivatives. As noted earlier, derivatives played a role in transmitting the shocks in the crisis. Not only was the infrastructure for clearing and settlement of over-the-counter derivatives (OTC) inadequate, but the complexity and diversity of the derivatives made it difficult for financial firms to fully assess their net exposure or communicate that exposure to counterparties and regulators. This lack of information fostered uncertainty that exacerbated the liquidity problems (Bernanke 2010, 11).

5. Origins of the Financial Crisis: Subprime Mortgages and Securitized Bonds

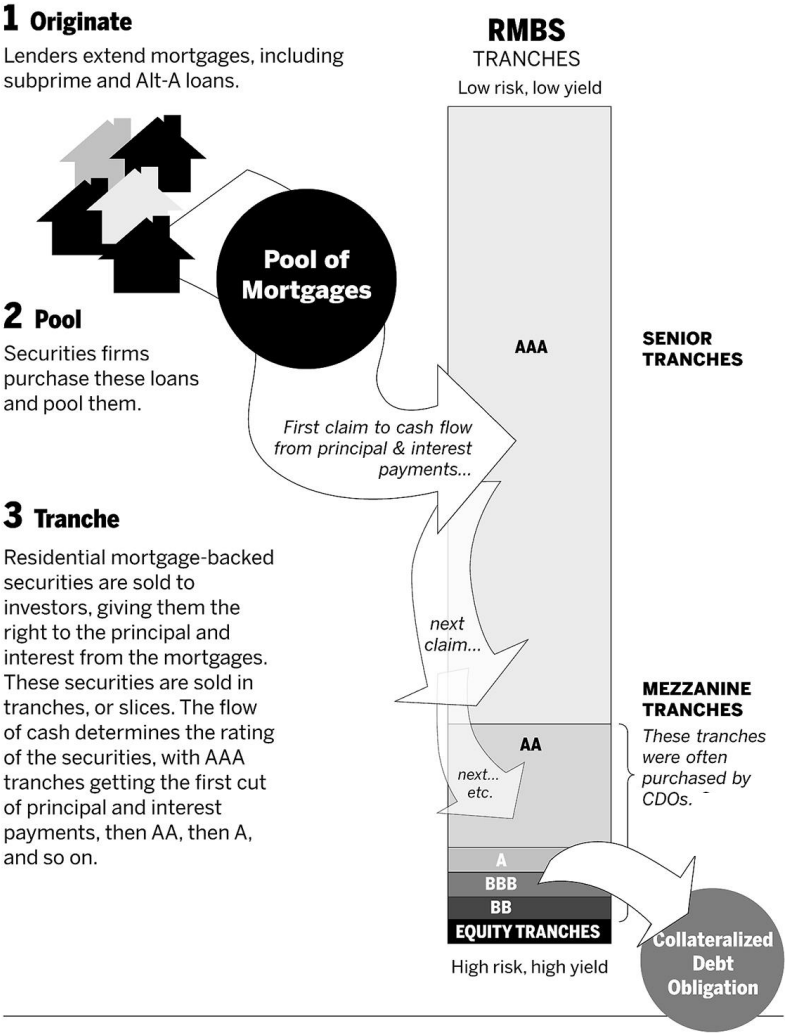
Although by mid-2007 there was roughly $1.2 trillion dollars in subprime mortgages outstanding (80 percent of which had been securitized) (Gorton and Metrick 2012A, 2), the subprime securitization market by itself was not large enough to account for the estimated $11 trillion that was lost as a result of the global financial crisis (FCIC Report, xv). A significant part of the explanation lies in the widespread ownership of securitized bonds. Uncertainty regarding subprime mortgages in some bonds infected liquidity and valuations of seemingly unrelated securitized bonds, resulting in liquidity issues for all institutions that relied on the "shadow banking system" for short-term borrowing. Those parties that needed cash had to sell into a depressed market, often at fire-sale prices, further spreading the contagion.

Transforming Mortgages into CDOs

U.S. housing prices had been rising at an unprecedented rate for much of the late 1990s into the early 2000s, a situation that combined with low interest rates to create a booming mortgage market. As illustrated by Figure 6, banks combined mortgages together and sold them as a type of structured debt, mortgage-backed securities (MBSs). (MBSs are also sometimes referred to as RMBSs, residential mortgage-backed securities, when comprised of noncommercial mortgages, or CMBS, when comprised exclusively of commercial mortgages.)

Figure 6: Residential Mortgage-Backed Securities

Financial institutions packaged subprime, Alt-A and other mortgages into securities. As long as the housing market continued to boom, these securities would perform. But when the economy faltered and the mortgages defaulted, lower-rated tranches were left worthless.



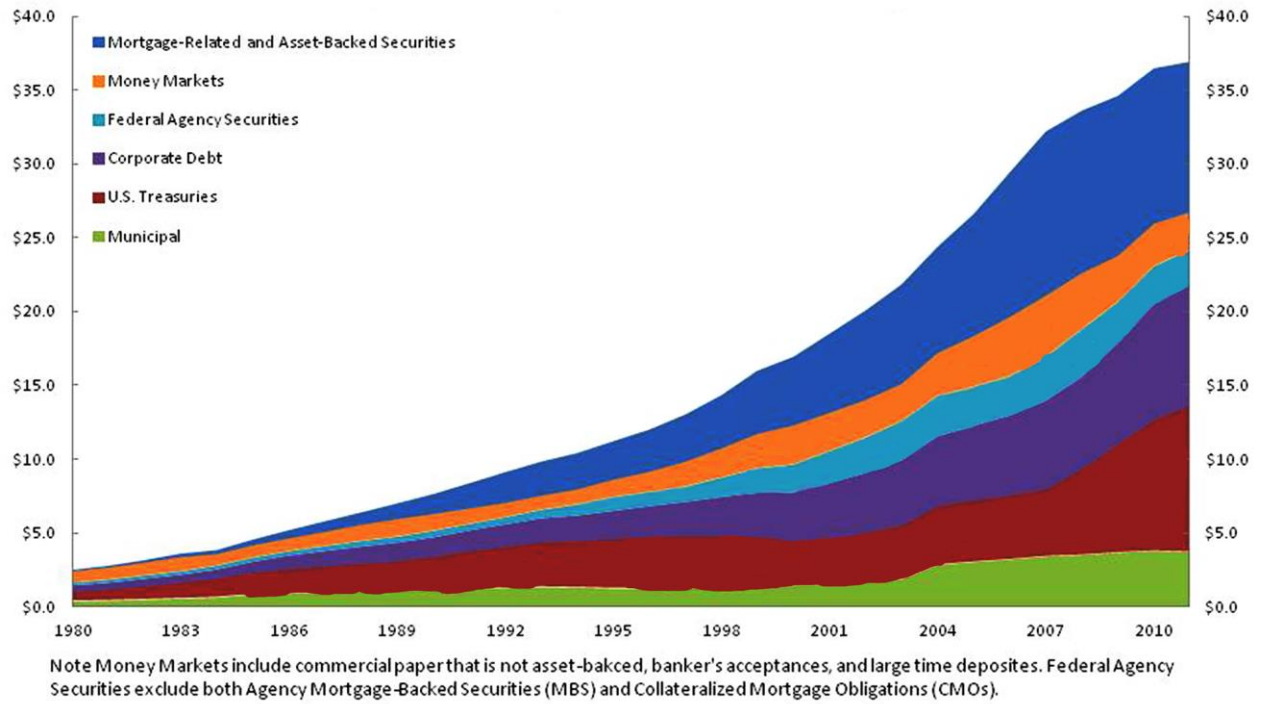
Source: Financial Economic Crisis Inquiry Report, p. 73, Figure 5.3.

As the world's cash glut continued, the volume of issued debt escalated, as can be seen in Figure 7, and investors sought out more safe assets.

To respond to the demand, banks began combining MBSs with other types of asset-backed securities (ABSs), such as those based on credit card receivables, auto loans, and student loans, to sell them as CDOs. To appeal to a range of investors, CDOs, like MBSs, were split into slices (tranches) that were rated according to their risk and the order in which the owner had a right to receive payments. (See Figure 8). Those with the rights to receive first payments (senior levels) were rated higher than those who received payments later (mezzanine and lower levels). Most often, CDOs utilized the more risky lower tranches of MBSs that incorporated subprime MBSs and that were more difficult to sell. By combining these lower-rated tranches with other ABSs, even tranches of CDOs incorporating subprime loans could gain AAA ratings. Subprime asset-backed CDOs proved very popular. As the demand for CDOs increased, they were aggressively sold to investors in all the world's major markets.

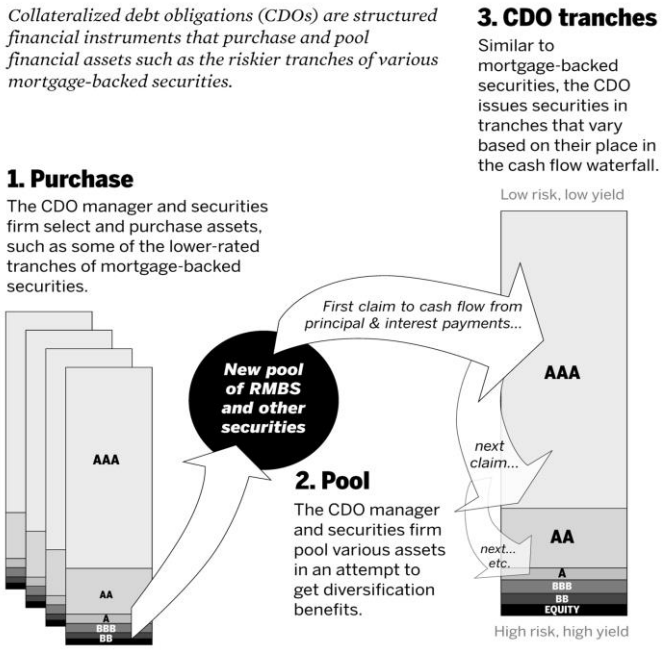
From 2002 to 2007, the subprime mortgage market boomed, and the proportion of ABSs that was subprime-related reflected this. (See Figure 9). Over time, a greater portion of the securities underlying CDOs became MBSs, and then subprime MBSs. "According to the Securities Industry and Financial Markets Association, the total U.S. issuance of asset-backed securities during the 2005-2008 period was $2.154 trillion, and the total U.S. issuance of CDOs during the 2005–2008 period was $987 billion" (Longstaff 2010, 439).

Figure 7: US Bonds Outstanding by Underlying Security 1980-2011 (US$ trillions)



Source: Securities Industry and Financial Markets Association.

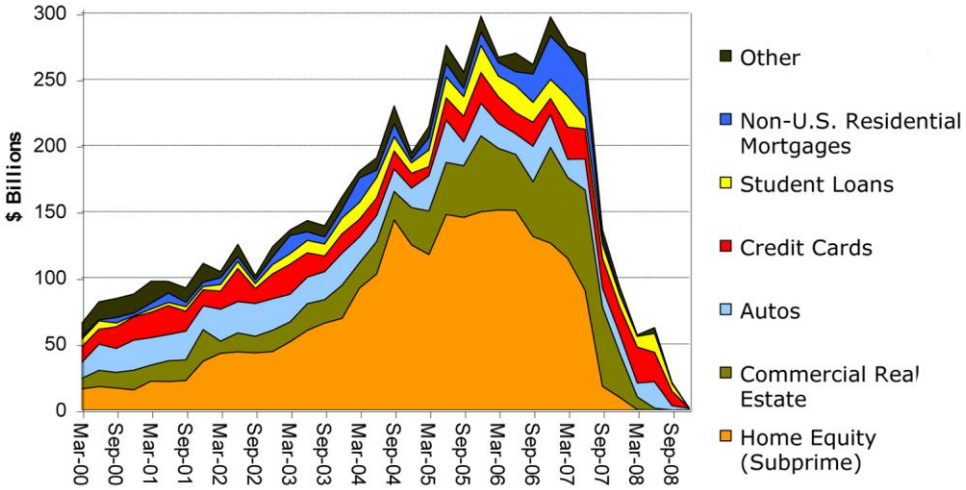
Figure 8: Collateralized Debt Obligations



Source: Financial Crisis Inquiry Commission Report, p.128, Figure 8.1.

The banks created an additional type of security by combining a group of CDOs into a derivative security termed a CDO-2 (CDO-Squared or Synthetic CDO), which was paid by the upflow from the combined CDOs. This type of bundling and re-bundling made it difficult to trace exactly where and how far CDOs were distributing risk. And distribution, it turns out, did not necessarily mean dilution.

Figure 9: New Issuance of Asset-Backed Securities



Source: JP Morgan, Chase and Adrian and Shin (2009).

These developments transformed the relatively small market of subprime mortgages into a major catalyst for economic downturn. Chairman Bernanke explained it this way:

> [O]ne of the things that created the contagion was [that] the subprime mortgages were entangled in these huge securitization pools, so they started to take losses and, in some cases, the credit agencies, which had done a bad job basically of rating them began to downgrade them. And once there was fear that these securitized credit instruments were not perfectly safe, then it was just like an old-fashioned bank run. And the commercial paper market began to pull their money out (Bernanke 2009, 10-11).

6. How Did Subprime Mortgages Shock the World's Economies?

As they became common, CDOs and other structured debt were routinely used as collateral for overnight sale and repurchase (repo) transactions which, along with commercial paper, had grown to become a significant portion of the unregulated short-term credit market or "shadow banking system" carried on by investment banks, hedge funds, and other institutional investors. Because repo is an unregulated interbank market, it is difficult to gauge the size of the market. However, 2007 estimates of amounts outstanding run as high as $10 trillion for the U.S. market (Gorton and Metrick 2012B, 433). (See Wiggins and Metrick (2014C) and Gorton and Metrick (2012B) for a detailed discussion of Lehman's repos, and the shadow banking system, respectively.)

Even though many investors chose to ignore such signs, U.S. housing prices peaked in the summer of 2006 and began to show signs of a steady weakening and decline. As housing prices declined, mortgage defaults escalated, because homeowners could not refinance their mortgages at favorable rates or found themselves underwater (i.e., their homes were worth less than their outstanding mortgages). The default rates were highest among subprime borrowers.

During the first half of 2007, several significant home mortgage lenders filed for bankruptcy protection, and on July 31, Bear Stearns halted all redemptions and liquidated two of its subprime mortgage-based hedge funds. These developments caused great concern about the overall subprime mortgage market, which magnified as uncertainty developed about where and how big the subprime exposures were. Concerned about risk, investors pulled back from lending to firms that they considered to have extensive exposure to the declining real estate market.

By summer 2007, the liquidity problem was becoming apparent. The first tremors were felt in a retraction in asset-backed commercial paper (ABCP). Investors feared that corporations could be holding subprime mortgages which might become illiquid and have to be marked down to market, negatively impacting firms' financial stability. Outstanding ABCP declined by $200 billion in August 2007 (Bernanke 2010, 2). Additionally, in the period from the "second quarter of 2007 to the first quarter 2009, net repo financing provided to U.S. banks and broker-dealers fell by about $1.3 trillion—more than half of its pre-crisis total" (Gorton and Metrick 2012C, 1).

Bernanke observed:

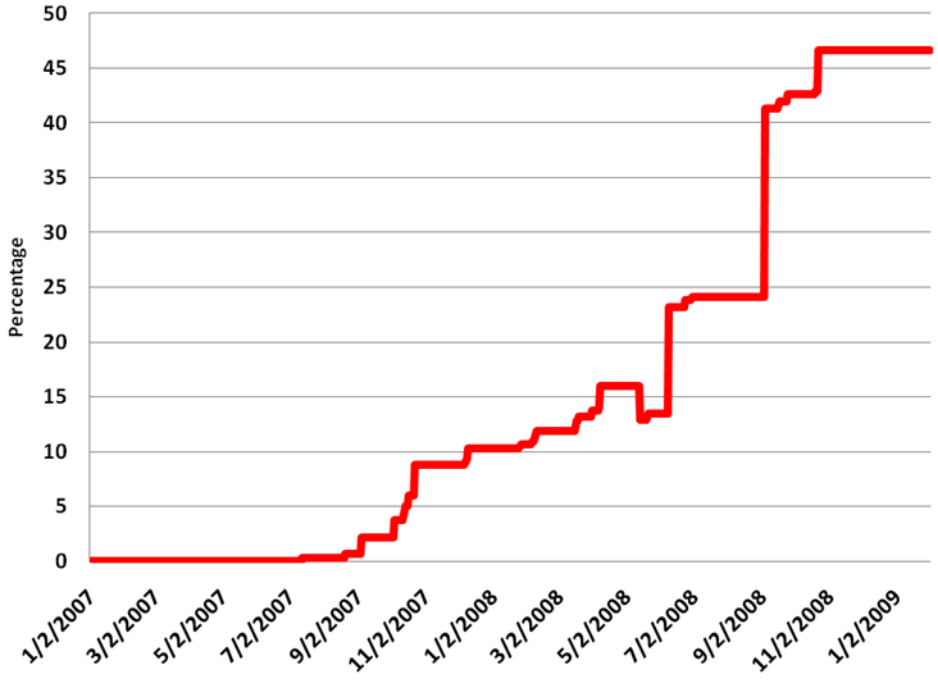
> Although subprime mortgages composed only a small part of the portfolios of most structured credit vehicles, cautious lenders pulled back from even those that likely had no exposure to subprime mortgages. The resulting pressure in turn transmitted

> to major banks that had sponsored or provided funding guarantees to vehicles (Bernanke 2010, 3).

Lending firms sought to protect themselves. As shown in Figure 10, beginning in September 2007, there was a noticeable uptick in the haircuts (discounts) demanded for funding. Lenders then restricted the types of collateral they would accept or refused to roll over repos at all. Borrowers facing funding restraints hoarded cash and, mirroring the classic scenario of a contagion spread by a liquidity transmission channel, sold assets to raise additional cash for use as collateral or to fund redemptions. Because they could sell only high-quality assets, they flooded the market with these, and often had to accept depressed prices, which further depressed prices.

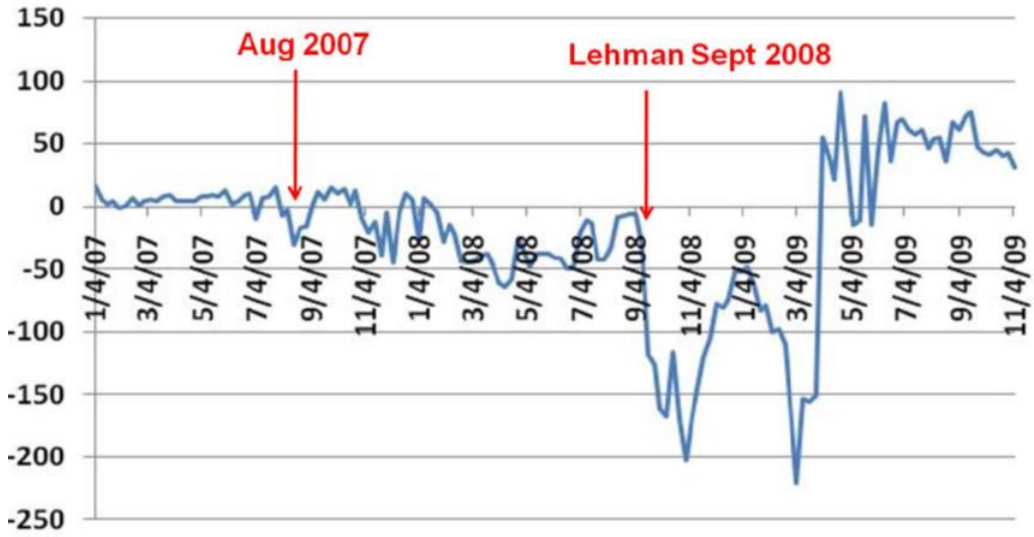
As Figure 11 shows, even prices on AAA-rated corporate bonds became depressed. Normally one would expect to pay more for a higher-rated (AAA) bond than for the lower-rated (AA) bond of the same denomination and terms, representing a positive spread between the two. One would expect the spread between the AA-rated corporate bonds and AAA-rated corporate bonds to always be positive. But during the crisis, so many AAA-rated corporate bonds were offered for sale that the spread had to rise to attract buyers, resulting in depressed prices for the higher-rated bonds. Such fire sales were a major source of losses during the crisis (Gorton 2010, 13-4). Both the disturbance in the repo market and the pressure from fire sales operated to squeeze Lehman's liquidity to a point that it was unable to fund itself. (See Gorton and Metrick (2012B), *Securitized Banking and the Run on Repo.)*

Figure 10: Average Repo Haircut on Nine Asset Classes, Two Categories of Corporate Bonds, and Seven Categories of Structured Products



Source: Gorton and Metrick (2012B).

Figure 11: The Spread between AA-Rated Corporate Bonds and AAA Corporate Bonds, both with Five-Year Maturities



Source: Gorton (2010).

6. Lehman's Bankruptcy and Its Global Impact

Beginning in early 2008, Lehman faced increasing questions regarding the value of its real estate assets and increased difficulty in trying to sell these assets.[13] Many lenders became unwilling to accept Lehman's real-estate-related assets as collateral for borrowings. As credit markets seized, Lehman was increasingly forced to deliver non-real-estate assets to secure funding as it also faced increasing haircuts. Following the near collapse of Bear Stearns in March 2008, rumors circulated that Lehman would be next to fail.

Unable to meet funders' demands, Lehman's U.S. holding company filed for bankruptcy protection on September 15, 2008, which sent new waves of disturbance and panic throughout the world's markets. On the same day, its U.K. broker-dealer was taken under supervision by the U.K. Financial Services Authority, freezing accounts and cutting off communication with the U.S. broker-dealer subsidiary that had been excluded from the U.S bankruptcy filing in hopes that it could be sold or wound down in an orderly way. Within a week, however, the U.S. broker-dealer was the subject of a Securities Investor Protection Corporation (SIPA) reorganization proceeding. (See Wiggins and Metrick (2014E).)

In the next few months, 22 Lehman affiliates around the world were taken into bankruptcy and had their accounts frozen. The fire sales of assets, the unwinding of Lehman's huge book

[13] At the end of its 2007 fiscal year, Lehman held $111 billion in commercial and residential real-estate-related assets and securities, an amount that was more than four times its equity of approximately $22 million, and more than twice the $52 billion in similar assets that it had reported at the end of the prior fiscal year (Examiner's Report, vol. 1, 62-3; Lehman 2007 10-K, 29). (See Wiggins et al., (2014A) for additional discussion of Lehman's real estate strategy.)

of derivatives, and various acts of self-protection by counterparties quickly escalated. As Lehman counterparties began to account for their exposures, they disclosed millions of dollars in potential losses.

Bernanke commented on the fallout from Lehman's bankruptcy:

> There is a view out there which says, 'Well, the problem wasn't the failure of these firms, but the fact that people didn't know what to expect. People thought that Lehman was going to be protected and, therefore, when it failed, it was a huge shock, and that led to the worsening of the crisis.' I find I'm very skeptical of this point of view. I don't think it has any real basis. And I would just point out as evidence that prior to Lehman's failure, the CDS spreads were blowing out, that everybody—every creditor was running to pull their money out of Lehman. The stock price was plummeting. This doesn't sound like a situation where people thought that Lehman was going to be protected. There was truly a lot of uncertainty, a lot of fear that Lehman would not be protected. And, in fact, it was that very fear and uncertainty that forced us into the situation in the first place (Bernanke 2009, 31-2).

The world's markets, which were still grappling with the subprime crisis and the negative impacts it spurred, were roiled by the shock of Lehman's collapse. The constriction of short-term credit markets that made it impossible for Lehman to fund itself only worsened as firms hoarded liquidity. The most vulnerable entities were soon brought to the brink. In September 2008 alone, major banks in the U.K. (Bradford and Bingley), Iceland (Glitnir), Belgium (Dexia), and the Netherlands (Fortis) were either bailed out or taken over with government support. In Ireland, failure of the three largest banks caused the government to take over the entire banking sector. Bernanke, the Chairman of the FED at the time, commented, "Our concern was about the financial system, and we knew the implications for the greater financial system would be catastrophic, and it was. It was worse than almost anybody expected." (See Zeissler et al. (2014C) regarding the Icelandic crisis, Wiggins et al. (2014D) and Wiggins et al. (2014C) regarding Dexia and Fortis, respectively, and Zeissler et al. (2014A) regarding the Ireland crisis.)

During the following weeks, the FTSE 100 stock index (U.K.) mirrored the precipitous drops that the Dow Jones Industrial Average experienced. Central banks from Europe to Asia scrambled to support their economies, infusing unprecedented amounts of funding into the markets. And in recognition of just how interconnected the major banks and their economies had become, there was unprecedented coordination among the central banks to calm the markets. On October 13, 2008, the Federal Reserve, the Bank of England, the European Central Bank, the Bank of Japan, and the Swiss National Bank issued a joint press release announcing joint action to support liquidity in short-term U.S. dollar funding markets. (See the *Timeline* at Appendix A for more information regarding impacts on the world's major financial markets.)

Although globally Lehman was the only major systemically important firm to collapse, which Chairman Bernanke attributes to the limited tools available to the U.S. government agencies, worldwide 15 to 18 major financial institutions were supported by their governments and likely would have collapsed if they had not been (Bernanke 2009, 24).

But the contagion was not just felt by financial firms and institutional investors; it had further economic effects. In a December 2009 survey of 1,050 chief financial officers of nonfinancial companies in 39 countries conducted by Campello, Graham and Harvey, the majority in each region responded that the crisis had negatively affected their operations. In the face of restricted credit markets with limited availability and/or higher costs, firms hoarded their

cash to maintain liquidity. They also drew down on credit lines to ensure availability, reduced expenditures and dividends, and coped with the downturns in business by reducing the number of employees. As shown in Figure 12, similar to the U.S., the impacts of the recession were felt far and wide throughout North America, the U.K., Europe, and Asia (Gorton and Metrick 2012A, 8).

Figure 12: The 2007-09 Recession Comparisons (in percentage change)

	Output	Consumption	Investment	Employment	Hours
US Postwar Recessions					
US Average of Postwar Recessions	-4.4	-2.1	-17.8	-3.8	-3.2
US 2007-09 Recession	-7.2	-5.4	-33.5	-6.7	-8.7
2007-09 Recession in Other High Income Countries					
Canada	-8.6	-4.6	-14.1	-3.3	-
France	-6.6	-3.4	-12.6	-3.3	-
Germany	-7.2	-2.9	-10.2	0.1	-
Italy	-9.8	-6.6	-19.6	-3.0	-
Japan	-8.9	-3.6	-19.0	-1.6	-
United Kingdom	-9.8	-7.7	-22.9	-2.9	-
Average other high-income countries*	-8.5	-4.8	-16.4	-2.0	-

*Canada, France, Germany, Italy, Japan, and the United Kingdom.
Source: Ohanian (2010). Available at Gorton and Metrick 2012A.

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Appendix A: Timeline of Financial Crisis Major Events

2006	
June	U.S. housing prices peak and start to decline.
2007	
Jan.–July	Massive downgrades of mortgage-backed securities by rating agencies.
January 2	Top 20 subprime mortgage underwriter Ownit Mortgage Solutions files for Chapter 11 bankruptcy protection claiming assets less than $10 million and debts owed of $170 million.
February 27	Freddie Mac Announces that it will no longer buy the most risky subprime mortgages and mortgage-related securities.
April 2	New Century Financial Corporation, the second largest subprime mortgage lender, files for Chapter 11 bankruptcy protection.
June 7	Bear Stearns informs investors that it is suspending redemptions from its High-Grade Structured Credit Strategies Enhanced Leverage Fund, which had invested heavily in subprime mortgage–backed securities. A group formed by Kreditanstalt für Wiederaufbau (KfW), a German government-owned development bank and several commercial banks, bail out German bank IKB, whose Rhinebridge structured vehicle suffered heavy losses from the downturn in subprime mortgages.
August	Problems in mortgage and credit markets spill over into interbank markets; haircuts on repo collateral rise; asset-backed commercial paper (ABCP) issuers have trouble rolling over their outstanding paper. Outstanding U.S. ABCP drops almost $200 billion.
August 9	BNP Paribus, France's largest bank, halts redemptions on three investment funds.
August 10	The Federal Reserve adds $38 billion in reserves and issues a statement reaffirming its commitment to provide liquidity.
August 16	Fitch Ratings downgrades Countrywide Financial, the country's largest subprime lender, to BBB+, its third-lowest investment-grade rating, and Countrywide borrows the entire $11.5 billion available in its credit lines with other banks.
August 17	Run on Countrywide Financial.
September 9	Run on U.K. bank Northern Rock, the United Kingdom's fifth-largest mortgage lender.

September 14	The Chancellor of the Exchequer authorizes the Bank of England to provide liquidity support for Northern Rock.
December	National Bureau of Economic Research subsequently declares December to be the business cycle peak.
December 12	The Federal Reserve announces the creation of the Term Auction Facility (TAF) that will auction term funds to depository institutions.
December 15	Citibank announces it will take its seven structured investment vehicles (with a value of $49 billion) onto its balance sheet.
2008	
January 11	Bank of America announces that it will purchase Countrywide Financial in an all-stock transaction worth approximately $4 billion.
February 17	Northern Rock is taken into state ownership by the Treasury of the United Kingdom.
March 11	The Federal Open Markets Committee increases its swap lines with the European Central Bank by $10 billion and the Swiss National Bank by $2 billion and also extends these lines through September 30, 2008. Federal Reserve announces the creation of the Term Securities Lending Facility (TSLF) to promote liquidity.
March 16	JP Morgan Chase announces that it will purchase Bear Stearns for $2 per share, less than 7% of its market value just two days prior, with $30 billion in assistance from the NYFED.
March 17	The Federal Reserve Board establishes the Primary Dealer Credit Facility (PDCF), extending credit to primary dealers at the primary credit rate against a broad range of investment grade securities.
July 13	The Federal Reserve Board authorizes the NYFED to lend to Fannie Mae and Freddie Mac, if necessary.
July 30	U.S. Congress passes the Housing and Economic Recovery Act of 2008 that was designed to address the subprime mortgage crisis. It established the Federal Housing Finance Agency (FHFA) and was intended to restore confidence in the Government Sponsored Enterprises (GSEs) but ultimately led to the conservatorship of Fannie Mae and Freddie Mac.
August 6	American Home Mortgage Investment Corporation, once the tenth-largest (non-subprime) mortgage lender, files for Chapter 11 bankruptcy protection.
September 7	The Federal government places Fannie Mae and Freddie Mac in government conservatorship.

September 10	Lehman Brothers preannounces expected $5.6 billion of write-downs on toxic mortgages and an expected loss of $3.93 billion for its third quarter. Moody's threatens to lower Lehman's debt ratings if a "strategic transaction with a strong financial partner" does not occur. Lehman's stock drops 40% to $4.22, down a total of 90% from its November 2007 value of $67.73.
September 12-14	The CEOs of the major Wall Street investment banks meet at the NYFED to try and reach a solution to save Lehman. The U.S. Treasury and Federal Reserve refuse to provide financial guarantees for a Lehman transaction. Despite interest, Bank of America and Barclays fail to close a deal.
September 15	Lehman Brothers announces that it will file for Chapter 11 bankruptcy protection. Bank of America announces that it is in talks to purchase Merrill Lynch for $38.25 billion in stock. The final agreement reflects that Merrill Lynch was sold for about $50 billion or $29 per share, a 70.1% premium over its September 12 closing price or a 38% premium over its book value of $21 a share. The Fed doubles the TSLF size to $200 billion and widens the asset set eligible as collateral for Treasury loans. A group of banks including Citigroup and J.P. Morgan set up a $70 billion fund to increase liquidity. The European Banking Community injects €30 billion and the Bank of England injects £5 billion into their respective economies. The Dow Jones falls 504.49 points (4.4%), its worst percentage decline since reopening after the 9/11 terrorist attacks. London's FTSE 100 Index closes down 291.80 points (3.9%).
September 16	The Federal Reserve bails out AIG, acquiring a 79.9% equity stake for $85 billion to keep it solvent. Eventually the government would hold 92% and invest a total of $152 billion. The Reserve Primary Fund, a money market fund (MMF), "breaks the buck," causing a run on MMFs.
September 17	The U.S. Securities and Exchange Commission announces a temporary emergency ban on short selling in the stocks of all companies in the financial sector. The Dow Jones falls 449.36 points (4.0%). The FTSE 100 Index closes down 221.10 points (2.25%). Russia suspends trading on its stock market for two days after the worst market falls since the country's 1998 financial collapse, and the Finance Ministry pledges a total of $60 billion of funds to help local banks.

September 18	The Federal Reserve coordinates with the Bank of England, the European Central Bank, the Bank of Japan, and the Swiss National Bank to inject an additional $184 billion into the world's banking systems to compensate for the lack of active lending.
September 19	News of the "bad bank" bailout plan and short-selling ban helps world stock markets soar. The Dow Jones climbs 387.97 points (3.39%). FTSE 100 closes up 431.3 points (8.80%). The U.S. Treasury announces a temporary guarantee of MMFs, and the Federal Reserve announces the Asset-Backed Commercial Paper Money Market Mutual Funds Liquidity Facility.
September 25	The authorities seize Washington Mutual, the largest savings and loan in the U.S., with $300 billion in assets.
September 28	The FDIC announces assistance for the Wachovia merger with Wells Fargo, and the Federal Reserve increases the size of the TAF.
September 29	The U.S. House of Representatives fails to pass the Bush Administration's $700 billion bailout plan, triggering the biggest one-day point drop in the history of the Dow Jones, 778 points (7.0%). The FTSE 100 also drops 418.80 points (5.30%). The U.K. nationalizes mortgage lender Bradford and Bingley. The Governments of Belgium, The Netherlands and Luxembourg bail out the Belgian-Dutch bank Fortis. Iceland takes control of the country's third largest bank, Glitnir.
September 30	Iceland guarantees all bank deposits for two years in an effort to stabilize its banks. The Governments of France, Belgium and Luxembourg bail out the Belgian bank Dexia.
October 3	U.S. Congress approves the Troubled Asset Relief Program (TARP), authorizing expenditures of $700 billion. The Dow Jones closes down 582.94 points (1.50%). The FTSE 100 gains 171.80 points (2.26%)
October 7	Control of two of Iceland's three largest privately owned banks, Landsbanki and Glitnir, is handed over to receivers appointed by the Financial Supervisory Authority. Federal Reserve announces the creation of the Commercial Paper Funding Facility (CPFF) to provide a liquidity backstop to U.S. issuers of commercial paper.
October 8	Central banks in the U.S., England, China, Canada, Sweden, and Switzerland, as well as the European Central Bank, cut interest rates in a coordinated effort to aid the world's economies.

October 13	Major central banks announce unlimited provision of liquidity to U.S. dollar funds; European governments announce system-wide bank recapitalization plans.
October 14	The U.S. Treasury invests $250 billion in nine major banks. FDIC announces the creation of the Temporary Liquidity Guarantee Program (TLGP).
November 23	Federal Reserve, Treasury, and FCI agree to provide Citigroup a package of guarantees, liquidity access, and capital.
November 25	Federal Reserve announces the Term Asset-Backed Securities Loan Facility (TALF) to support the issuance of Asset Backed Securities (ABS).
2009	
January 16	The U.S. Treasury Department, Federal Reserve, and FDIC announce a package of guarantees, liquidity access, and capital for Bank of America totaling $118 billion.
February 17	President Obama signs into law the American Recovery and Reinvestment Act of 2009, which includes a variety of spending measures and tax cuts intended to promote economic recovery.
May	Results of the Supervisory Capital Assessment Program ("bank stress tests") are announced. Many banks are required to announce additional capital.
June	The National Bureau of Economic Research subsequently declares June to be the business cycle trough.
October	U.S. unemployment rate peaks at 10.0 percent.

Sources: Federal Reserve Bank of St. Louis and Gorton and Metrick 2012C.