The Financial Crisis of 2007-2008

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The financial disaster of 2007-2008 had long-lasting and global repercussions of a staggering magnitude. My principal aim in writing a greatly revised second edition of my textbook *Financial Risk Management* was to directly address the risk management failures that were critical contributors to this crisis and the lessons I think it is vital to learn from it. I devoted a 50 page chapter (Chapter 5) in my second edition to the 2007-2008 disaster, but I recognize that it is too technical and too detailed for many people who would be interested in obtaining some insight about it. This shorter and far less technical paper is my attempt to make my arguments and conclusions available to a wider audience. I will provide references to the relevant sections of my book and to other articles and books about the crisis for those looking to pursue a particular point in more depth.

I will first present a summary of my primary conclusions and then provide a section for each conclusion of evidence to support it.

1. With virtually no exceptions, **credit losses** have been the cause of financial crises of sufficient scope to bankrupt major institutions, to be industry-wide in nature, and to have a more than brief impact on economies. The 2007-2008 incidents followed this pattern, with the primary cause being credit losses sustained by large banks in mortgage lending to homeowners who could not meet the standards for government-guaranteed mortgages (known as “subprime” mortgages), with a significant secondary cause being credit exposures that one large bank had to another large bank.
2. Conversely, **trading losses** are virtually never large enough to bankrupt any but a smaller institution and are idiosyncratic, impacting only one or two institutions rather than being industry-wide, except to the extent that **credit** exposures allow **contagion** of losses.
3. The main driver of the 2007-2008 crisis was large losses by large investment banks on credit derivatives they originated from pools of home mortgages (data indicating that this was the main driver can be found at the beginning of Section 5.2.5). A primary factor in the devastatingly large impact of the 2007-2008 losses was the failure of risk management, both within individual firms and by government regulators, in allowing long-term credit exposures to be **incorrectly classified** as short-term trading exposures. This led to both a failure to recognize the large magnitude of credit exposure and an accounting treatment that was wholly inappropriate for credit exposure. Long-established accounting treatments that had an excellent track-record in allowing economies to recover over time from credit losses were unavailable due to this gross misclassification.
4. The belief by some that incorrect **models** played a major role in triggering the crisis is largely misplaced. The misclassification that was at the heart of the disaster needed only simple tests to identify it, not any mathematical models. In particular the emphasis that some analysts have placed on the failure of value-at-risk (VaR) models is wholly incorrect – the kind of risks that caused this crisis were not ones that anyone had ever believed could be addressed by VaR models.
5. The belief that a primary cause of the disaster was risk managers being “fooled” by greedy and irresponsible business managers is largely misguided. Greed and irresponsibility certainly played a large part, but these are fairly constant factors in the business landscape that risk management, both within firms and by government regulators, is supposed to be designed to counteract.
6. While many of the responses to the crisis were just reiteration of previously recognized best practices, or were very specific to addressing the particular flaws that this triggered the crisis – such as tightening standards for classifying credit risk as a trading exposure – three general innovations deserve to be singled out as very welcome additions to risk management controls: (1) The recognition by government regulators that as the last line of defense in absorbing losses by financial institutions, they are the proper source for setting economic stress test parameters that financial firms must maintain sufficient capital to withstand; (2) Greater insistence by government regulators on clearing mechanisms for derivatives trades between financial institutions that substantially reduce the threat of credit contagion, with heavy capital requirements on those trades that cannot utilize these clearing mechanisms; and (3) Greater emphasis on the need for both firm risk managers and government regulators to get involved in the details of performance measurement and compensation arrangements that can lead to perverse incentives that do not reflect the degree of risk that results from a business decision.

**Analysis**

I acknowledge that I cannot draw upon the firsthand detailed familiarity

that would come from working in risk management at one of the affected institutions during the crisis period—I retired from JPMorgan Chase in 2004 and was working during the crisis period primarily as an educator. I have based my account on a combination of what is in the public record, what I have gleaned from conversations with people who were on the inside during the crisis, and what I have seen as an independent consultant to some of the impacted firms in the aftermath of the crisis. Balancing this, my lack of participation in the crisis leaves me relatively free of any axes to grind, positions to defend, or constraints due to confidentiality (though I can’t identify, either explicitly or by implication, specific clients I worked for after the crisis). A detailed listing of those books and articles I have based my conclusions on can be found in Chapter 5 of my book.

**(1) The impact of credit losses**

The banking industry across many countries and over many years has been subject to periodic crises due to loan losses. *This Time is Different* by Reinhart and Rogoff is a good history of these crises and their doleful impact on national economies.

**(2) The limited impact of trading losses**

In Chapter 4 of my book, I have summarized the disasters in the operation of financial markets that have occurred over the past 50 years.

While a few of these disasters did lead to either bankruptcy or severe crippling of the firm (Kidder Peabody, Barings, UBS, Bankers Trust), the damage was largely confined to a single firm and did not have a major impact on the economy. Other disasters caused a temporary blow to the profitability and reputation of the firm involved but were not crippling to the business. The only case, other than the CDO-fueled disaster of 2007-2008, that truly threatened a spreading crisis was the bankruptcy of Long-Term Capital Management (see Section 4.2.1). But, as I document in my analysis, this was primarily due to poor management by large banks and investment banks of their **credit** exposure on Long-Term Capital’s positions.

The conclusion that I would draw is that large trading losses tend to be idiosyncratic to a particular firm and do not constitute the economy-wide threat that credit crises can pose. Why then was the CDO crisis so damaging to economies? My belief is that it was so damaging because it was essentially a credit exposure disguised as a trading position, as will be detailed in the next section.

**(3) Incorrect classification of CDOs**

This is a summary of section 5.2.5 of my book.

What was different about credit losses that resulted from CDOs rather than from loans? The illusion that CDOs were bringing more liquidity to the mortgage lending market resulted in an exacerbation of what might otherwise have been a far more manageable downturn. Treating the CDOs as if they were liquid securities rather than illiquid loans helped to fuel an expansion in lending far beyond what probably would have occurred without it. Then, when it became clear that the alleged liquidity wasn’t really there, the commitment of the investment banks to accounting for CDOs as if they were liquid assets turned what would have been longer-term losses to be dealt with over the length of a credit cycle into immediate requirements for raising new capital. This quickly led to contagion in which markets, securities and firms not originally involved in the CDO market got heavily impacted as well.

Investment banks who were among the major creators of CDOs were also the group that suffered the heaviest losses in the 2007-2008 meltdown. An International Monetary Fund (IMF) analysis found that 60% of the $1 trillion in losses on US originated mortgage CDOs came from banks while only 5% came from the mutual funds, pensions funds, hedge funds, and other non-bank financial institutions who were the primary clients to whom the investment banks marketed the CDO tranches.

This is both unfortunate and surprising. Unfortunate, because concentrated losses by large banks are far more damaging to the economy than the same amount of losses spread out over smaller banks and investors. Surprising, because the sophistication, intimate familiarity with the product, and originate to distribute business model should all have worked to protect the investment banks.

How then did investment banks wind up with so much mortgage CDO exposure? The initial mechanics of the situation are fairly straightforward. Clients were eager to purchase CDO tranches, thereby selling protection against mortgage defaults, but they were only interested in the *mezzanine* tranches that carried intermediate expected loss. The highest expected loss tranches, the so-called equity tranches, attracting the first losses, could not have achieved investment grade ratings and were not considered suitable investment vehicles for most clients (though some hedge funds did take on this risk, mostly through derivatives). Also, it was considered appropriate that the CDO creator hold the equity tranche. The tranches with the lowest expected loss, termed *super-senior* because they supposedly had a statistical probability of loss even lower than AAA rated corporate bonds, did not have a strong client demand. Because of their very low loss expectation, they carried very low credit spreads, just a few basis points, and it was virtually impossible to find a client who wanted to use valuable balance sheet room to earn such a meager return. (It might be thought that super-senior tranches would be a possibly attractive investment as an alternative to Treasury securities that had similarly low returns, but Treasury securities had many advantages in terms of liquidity and attractive repurchase rate funding opportunities that super-seniors lacked).

Here was a dilemma for the investment banks. To create more mezzanine tranches for which there was high demand they also needed to create super-senior tranches for which there was virtually no demand. Of course, one alternative would have been to substantially raise the yield on the super-seniors to the point that demand was created, but this would have so severely cut into the profitability of the overall transaction that it wasn’t seriously considered. Their only alternatives were to stop the flow of lucrative new business or to pile up super-senior tranches on their own balance sheets. They almost all chose the latter option. As Chuck Prince, the soon-to-be-ex-CEO of Citigroup, infamously said in July 2007, “as long as the music is playing, you’ve got to get up and dance. We’re still dancing”. It was this continuous build-up of super-seniors, totally lacking a liquid market, which was the source of almost all of the large CDO losses suffered by the investment banks. For example, the UBS report to shareholders showed that about $9 billion of its $12 billion 2007 losses on CDOs were due to super-senior tranches. Other large investment banks that followed this pattern included Citigroup, Merrill Lynch, Morgan Stanley, and Bear Stearns (see *Fool’s Gold* by Tett Chapter 9). Writing generally about investment banks that experienced large losses in 2007, the Senior Supervisors Group report of March 2008 on p. 8 states “some firms continued to underwrite or increase their exposures until the summer of 2007 despite an array of data indicating rising stress in the subprime mortgage market and worsening credit market conditions.”

If management of these banks had placed sensible limits on the size of super-senior holdings or had insisted on mark-to-market valuations of the holdings that reflected their total lack of liquidity (thereby lowering the profit that could be recognized on new CDO issuance and shrinking bonus pools), the entire mortgage CDO creation process would have come to a halt at a fairly early stage and the damage to the financial industry and the world economy would not have been nearly so severe. As Richard Bookstaber, an experienced senior risk manager put it in his testimony before the Financial Crisis Inquiry Commission, “As everybody in any business knows, if inventory is growing, that means you’re not pricing it correctly… It was a hidden subsidy to the CDO business by mispricing.” (FCIR (2011) p. 196).

Theilliquidity of super-senior tranches should have been evident to anyone involved in investment banking, even those most remote from direct trading and marketing of CDOs, just by the fact that it was such a problem to find willing buyers. (Section 5.2.5.8). But the Senior Supervisors Group report of March 2008 p. 3 finds that “firms that faced more significant challenges in late 2007…continued to price the super-senior tranches of CDOs at or close to par despite observable deterioration in the performance of the underlying…collateral and declining market liquidity.” The UBS report to shareholders Section 6.3.6.4 states that “The Super Senior notes were always treated as trading book (i.e., the book for assets intended for resale in the short term), notwithstanding the fact that there does not appear to have been a liquid secondary market and that the business tended to retain the Super Senior tranche.”

Why were firms treating such clearly illiquid instruments as liquid? One clear motivation is alluded to in the same section of the UBS report – “Treatment under the ‘banking book’ would have significantly changed the economics of the CDO desk business as this would have increased the required regulatory capital charges.” Classifying assets in the trading book, available for resale in the short term, attracted more favorable capital treatment than the same assets placed in the banking book, intended to be held. Note that this is just a statement of intention – nothing stops you from selling assets in the banking book; loan sales occur all the time. But this statement of intention was allowed to impact required regulatory capital, a major driver of the economics of a product (this loophole was closed after the CDO-fueled crisis revealed its short-sightedness; the BIS Incremental Risk Capital Guidelines of July 2009 made capital requirements for credit products held in the trading book and banking book essentially equivalent – see *Pricewaterhouse Coopers 2011 A Practioner’s Guide to Basel III* Section 4.6.3.5). It also impacted the balance sheet reporting that might impact public perception of the degree of liquidity of the firm’s assets.

My guess, and it’s only a guess, is that the mechanism that operated at some firms was that the potential liquidity of CDOs, including super-seniors, had been emphasized in order to obtain the favorable capital treatment – securities are, in general, more liquid and likely to be sold than loans. While this accounting decision should not have forced a similar classification by risk managers, it is not uncommon for this kind of distinction between accounting principles and risk management principles to get blurred.

This incorrect classification of highly illiquid assets as liquid trading account assets also contributed to severely inadequate stress testing. Opinions by some mainstream economists, backed by detailed statistical analysis, throughout 2004 through 2006 were pointing towards a fall in US housing prices over a two to three-year period ranging from 20% to 50% (see Section 5.2.5.7 for details). A strong and detailed argument for a given viewpoint is no reason it can’t be rejected as a most likely, or even as a reasonably probable, view; but it can’t be rejected as a plausible view, which should certainly trigger its inclusion as a stress test. But by treating super-seniors as liquid assets, risk managers only need to be worried about stress tests of what might be reflected in the market over a period of a few weeks and so could ignore the implications of this scenario for the longer-term outlook for their super-senior holdings.

Some investment banks used other devices to help disguise the degree of exposure they had to highly illiquid instruments. Some relied on the supposed protection of derivatives contracts that had no collateralization or very weak collateralization and which were therefore unlikely to offer much actual protection in adverse circumstances (see Section 5.2.5.1). Some relied on booking trades in off-balance-sheet vehicles which were supposed to shield the originating firm from further exposure but had sufficient ties to the originating firm to call the adequacy of this protection into question (see Section 5.2.5.2). Some hedged super-senior tranche positions with positions in other types of CDS which did not have a sufficiently strong relationship to the super-senior tranches to provide adequate protection (see Section 5.2.5.6). In all cases, I believe the fundamental problem was still the failure to recognize the extreme illiquidity of the super-senior tranches, which should have called for very close scrutiny of any claims for reducing risk short of an outright sale.

**(4) The role of models**

I will look at the role played by three types of models: (1) industry CDO models, (2) rating agency CDO models, and (3) VaR models.

Industry CDO models

This is a summary of section 5.2.5.3 of my book.

Felix Salmon’s February 2009 story for *Wired* magazine, “Recipe for Disaster: The Formula That Killed Wall Street” (Salmon (2009)) brought David Li’s version of the Vasicek model of credit defaults, which uses a single factor approximation to represent default correlations, to the attention of a wider audience than financial industry quants. The article led off with statements such as “One result of the [2008 financial system] collapse has been the end of financial economics as something to be celebrated rather than feared. And Li’s Gaussian copula formula will go down in history as instrumental in causing the unfathomable losses that brought the world financial system to its knees.” With this as background, I was somewhat surprised in my survey of the principal book-length writings and journal articles on the crisis to see scant mention of either the Li model or the Vasicek model. Did faulty CDO modeling play a significant role in the crisis?

The case for faulty CDO models playing, at best, a minor role in the crisis would go as follows:

The Li model was primarily being used as an interpolation tool from more common tranches for which price quotes could be obtained to less common tranches. As such, its use was very similar to that of the Black-Scholes model in interpolation of options prices and the use of fitting to a correlation skew implied by the market as part of the interpolation shows that the Gaussian copula assumptions of the Li model were not being taken very seriously by the traders using it.

The Li model was also being used as an aide to intuition and as such it did its job admirably. In fact, it was particularly valuable in letting users see the degree of systematic risk embedded in different tranches, which should have directed attention to the riskiness of super-senior tranches.

The emphasis on the correct estimation of correlation levels and the shape of the correlation copula was very important for traders making decisions on the value of tranches. Had the tranches been liquid, this would also have been important for risk managers, in estimating where liquid positions could be exited. But given the illiquidity of super-senior tranches, stress testing large changes in the common factor, closely linked to real estate prices, was overwhelmingly more important for risk managers than stress testing of either correlation level or copula shape.

When investment banks wanted to perform more fundamental analysis of tranche pricing and risk, they were hardly lacking for more sophisticated versions of CDO models, with many models dating from the first half of the 2000’s decade and widely available – often referenced and explained in papers published by investment bank research teams, in the well known 2003 book *Credit Derivatives Pricing Models* by Schonbucher, and in many issues of *Risk* magazine from that period.

And yet, I think there is one key way in which CDO models utilized by investment banks in this period were misleading. Too much emphasis was placed on fitting model parameters to observed market prices without an adequate consideration of the degree of illiquidity that pervaded many sectors of this market, including the entire super-senior sector

Ratings Agency CDO models

This is a summary of Section 5.2.5.4 of my book.

It is uncontroversial that the ratings agencies models played a significant role in fueling the demand for CDO tranches by investors (see Section 5.2.3). But could they have also played a role in the willingness of investment banks to tolerate so large an exposure to super-seniors? At first glance, this seems preposterous. The investment banks in their role of CDO creators had intimate knowledge of the ratings agency models and knew the extent to which they, the investment banks, had manipulated those models. (The CDO structurers used their knowledge of the rating agency models to play with the structure until they optimized the disconnect between the risk represented by the rating and the true risk, maximizing their profits). How could they then rely on those models to take comfort with their exposure?

And yet one finds in the March 2008 UBS report to shareholders, Section 5.3.2, that the UBS market risk control group’s “VaR methodologies relied on the AAA ratings of the Super Senior positions. The AAA ratings determined the relevant product-type time series to be used in calculating VaR…As a consequence, even unhedged Super Senior positions contributed little to VaR utilization.” *Fool’s Gold* by Tett p. 139 quotes Peter Kurer, a member of UBS’s board as saying “Frankly most of us had not even heard the word ‘super-senior’ until the summer of 2007. We were just told by our risk people that these instruments are Triple-A, like Treasury bonds.” Anecdotal accounts I have heard from other investment bank risk managers indicate that UBS was not alone in utilizing AAA ratings of tranches as an invitation to calculate risk statistics for them based on time series of price moves of AAA corporate bonds. The March 2008 Senior Supervisor Group report on the risk management practices of investment banks leading up to the crisis states that at some firms “internal risk capital measures that relied too much on agency ratings underestimated the true price of the risk of such positions” and that some firms “tended to assume that they could apply the low historical return volatility of corporate credits rated Aaa to super-senior tranches of CDOs” (p. 5). It further states on p. 3, “Given that the firms surveyed for this review are major participants in credit markets, some firms’ dependence on external assessments such as ratings agencies’ views of the risk inherent in these securities contrasts with more sophisticated internal processes they already maintained to assess credit risk in other business lines.”

The impression left is consistent with the picture of front-office personnel not sharing their knowledge of ratings agency model limitations with risk managers.

VaR Models

This is a summary of Section 5.2.5.5 of my book

UBS (and, anecdotally, some other investment banks) used the AAA ratings of super-seniors as a short cut in VaR calculations, essentially treating any AAA rated security as if its price movements could be represented by a time series drawn from AAA corporate bond prices. This was clearly an error, the volatility of tranche prices is expected to be quite different from the volatility of corporate bonds of the same rating (senior CDO tranches concentrate systematic undiversifiable risk in a way that corporate bonds do not; see Section 13.4.4 of my book). But an even more important question is why were firms even bothering to calculate VaR, a measure of vulnerability to short-term price fluctuations, for an instrument as illiquid as super-seniors.

Now, perhaps this was just a calculation of VaR for a liquid proxy hedge of the super-seniors and the bulk of the risk was going to be evaluated elsewhere (a measure I strongly advocate, as can be seen in Section 6.1.2 of my book). If this was the case, then even the use of the computational short cut might be justified – you would be choosing a portfolio of AAA corporate bonds as your liquid proxy hedge. It may not be the best choice, but as long as you are calculating the long-term risk of the hedge separately no great harm will be done. But this does not appear to be the way UBS (or, anecdotally, some other investment banks) were operating. VaR was intended to be the primary risk measure for the super-seniors. Quoting UBS (2008) Section 6.3.2, “Investment bank business planning relied upon VaR, which appears to be the key risk parameter in the planning process. When the market dislocation unfolded, it became apparent that the risk measure methodology had not appropriately captured the risk inherent in the businesses having Subprime exposure.”

**(5) Were risk managers fooled by greedy and unscrupulous traders?**

No doubt greed and deceit played a major role in the build-up to the crisis. But risk management functions are not designed to be trusting; they are supposed to be wary and empowered to deal with these factors. Sections 2.1 and 2.2 of my book describes the well-recognized role of **moral hazard** in financial markets: the advantage that insiders such as traders and marketers have in possession of information that outsiders like risk managers and government regulators lack, coupled with the temptation to exploit that advantage in pursuit of narrower objectives. Risk management has developed a large tool kit of well-established practices for dealing with this issue, described in both Section 3.1 and throughout Chapter 6. No risk manager should ever try to deflect blame by claiming that his or her “trust” was abused.

**(6) Major innovations in risk practice spurred by the crisis**

Basing required capital on stress tests with key economic parameters specified by government regulators

The Wikipedia article on “Stress test (financial)” gives a good summary of the steps that have been taken by regulators to base required capital on regulator-defined stress tests. My argument in favor of this change (see Section 5.5.5.3) is that capital requirements directly tied to stress test scenarios focuses management and regulatory attention in exactly the right place – on the impact of large moves in major economic variables, exactly the types of event that have challenged the health of financial firms and of the financial system. It is this type of event, significant drops in price of important asset classes, for which capital cushions are needed.

Whatever level of possible stress market move corresponds to the capital requirement, there will always be some possibility that an extreme market move will exceed this level and require some absorption of loss by tax-payers on behalf of depositors. Since it is the regulatory authorities who represent the taxpayers’ interests, they should be the ones to determine the level of protection. There are inevitable trade-offs between capital requirements that are too high and which hurt economic activity and capital requirements that are too low and create too high a risk of potential crisis. It is the regulatory authorities acting on behalf of government that should be weighing these consequences and deciding on the correct balance.

The risk managers of a firm should possess specialized knowledge regarding the trading positions and activities of that firm. There is no reason to think they would possess any specialized expertise about the probability of macroeconomic events, such as large moves in a stock indices, government bond rates, or housing prices. So I do not see any comparative advantage argument in favor of having these stress levels set by firm risk management as opposed to government regulators. Furthermore, when firm risk managers set the stress levels, there is an inevitable competitive pressure to set levels lower to free up capital and improve returns. A common level set by regulatory authorities eliminates the competitive advantage a firm could get by hiring more “optimistic” risk managers.

Greater insistence by regulators on clearing mechanisms for derivatives trades that reduce the threat of credit contagion

The use of clearing mechanisms such as exchange-traded and exchange-cleared derivatives greatly reduces potential credit contagion when a counterparty fails. Closely tied to this are capital requirements that accurately reflect risk exposure in light of these clearing arrangements. Section 5.5.7 of my book offers a brief summary. For a more complete treatment, Jon Gregory’s book *The xVA Challenge* is an extremely valuable resource.

Greater involvement by firm risk managers and government regulators in the details of performance measurement and compensation arrangements that can lead to perverse incentives

Section 5.5.5.2 outlines some of these measures which include: making sure that compensation is adjusted for all forms of risk taken and is symmetric with respect to gains and losses; tying payout schedules to the time horizon of risks, with some part of compensation deferred until the outcome of actions can be fully assessed; assuring adequate public disclosure of compensation practices. There is a recognition that compensation is an incentive system and not just a market wage and hence compensation practices need to be reviewed as part of the supervisory role of regulators and risk managers.