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Advanced Financial Risk Management:

Tools and Techniques for Integrated Credit Risk, Market Risk, Liquidity Risk and Interest Rate Risk Management

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Introduction: Wall Street Lessons from Bubbles

The credit crisis which began unfolding in the United States and Europe in 2006 contains a treasure trove of lessons for risk managers which we have tried to incorporate in detail in this book. Each of the authors has worked in Japan and we felt strongly that the collapse of the Japanese bubble, which peaked in late 1989, contained equally useful lessons for risk managers. As you'll note in the "key fallacies in risk management," discussed below, many ignored the lessons of the Japanese bubble because of the common fallacy that "if it hasn't happened to me yet, it won't happen to me, even if it's happened to someone else."

Now that the United States and much of Europe are experiencing the collapse of a bubble much like that which burst in Japan, the lessons from each of these bubbles seem much more relevant to risk managers world-wide.

We have worked hard in the second edition of this book to severely de-emphasize the discussion of financial models which are obviously inaccurate, misleading, or clearly inferior to another modeling approach. We make this judgment on the basis of cold hard facts (via model testing) or because of assumptions that are known to be false. The list of models which failed under the duress of the credit crisis is a long one, and we make no apologies for reflecting those failures in this book. We've also worked hard to explain which models performed well during the credit crisis. Again, we base that judgment on model testing and the logical consistency and accuracy of the assumptions behind those models.

Each of the authors believes in a "multiple models approach" in risk management. That doesn't mean, however, that all models used are equally accurate. Nothing could be farther from the truth. The use of a multiple models approach, however, makes it clear when a better model has been brought to the risk management discipline and when it's time for an older model to be removed from the tool kit. One of our elegant British friends once commented that "I don't think it's gentlemanly to compare the accuracy of two models." The authors, by contrast, believe that such comparisons are a mandatory part of corporate governance and best practice risk management.

With that brief introduction we now turn to a short summary of some common fallacies in risk management which have been exposed as fallacies very starkly in the wake of the recent credit crisis.

Key fallacies in risk management

Summarizing the dangerous elements of conventional wisdom in risk management isn't easy. We've restricted ourselves to a limit of the seven most dangerous ways of thinking about risk. Each of them has much in common with this famous quote of John Maynard Keynes from "The Consequences to the Banks of the Collapse of Money Values" in 1931: "A sound banker, alas, is not one who foresees danger and avoids it, but one who, when he is ruined, is ruined in a conventional way along with his fellows, so that no one can really blame him." We summarize them here and discuss each briefly in turn:

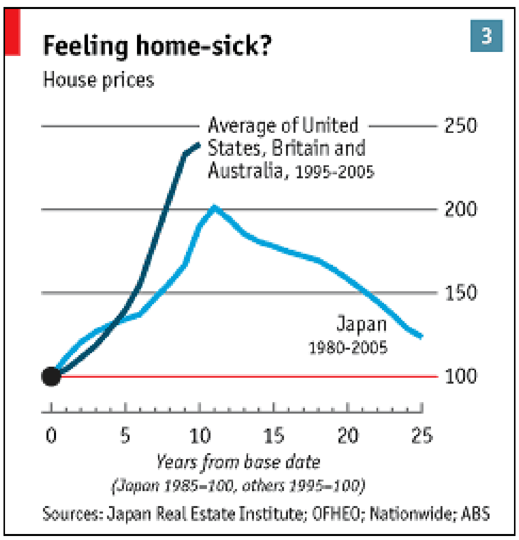
- If it hasn't happened to me yet, It won't happen to me, even if it's happened to someone else
- Silo risk management allows my firm to choose the "best of breed" risk model for our silo.
- I don't care what's wrong with the model. Everyone else is using it.
- I don't care what's wrong with the assumptions. Everyone else is using them
- Mathematical models are superior to computer simulations
- Big North American and European banks are more sophisticated than other banks around the world and we want to manage risk like they do
- Goldman says they do it this way and that must be right

We discuss each of these fallacies in turn.

If it hasn't happened to me yet, it won't happen to me, even if it's happened to someone else

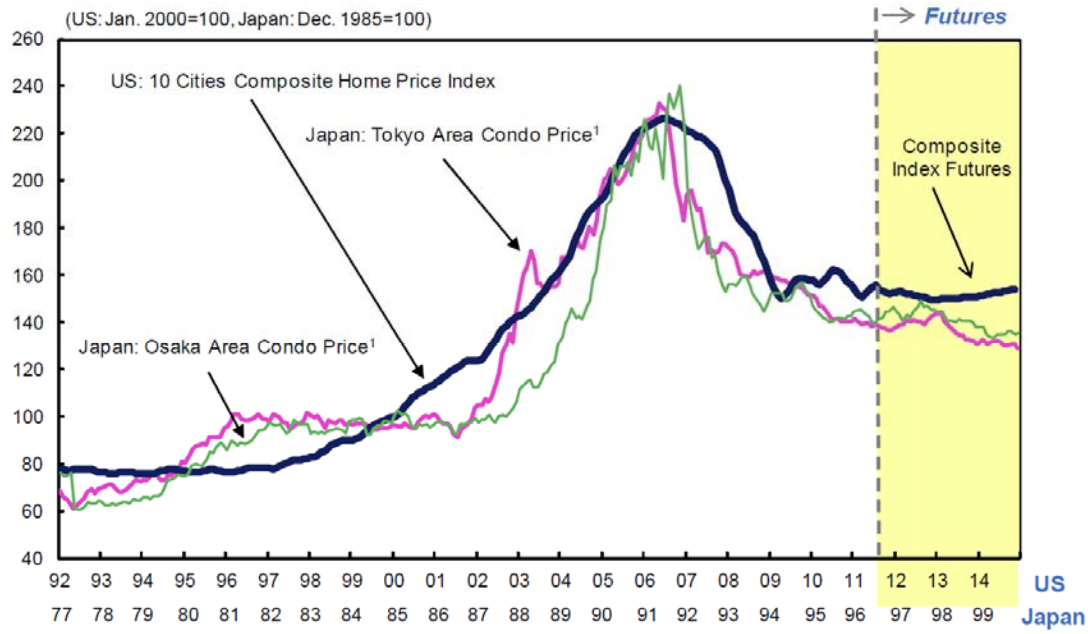
The perceived risk in any given situation is often a function of the age, the location, and the personal experience of the person making the risk assessment. There are lots of examples. Some motor cycle riders don't wear helmets. Some smokers think cancer happens to other people. In risk management, perhaps the biggest mistake in 2005 and 2006 was the assumption that "home prices don't go down" in the United States, in spite of evidence like this from the Economist (June 16, 2005):

Figure 1



Of course, this assumption was dramatically wrong. It's best illustrated by Richard C. Koo ("The world in balance sheet recession: causes, cure, and politics," Nomura Research Institute, 2011) in this figure, showing how similar the collapse in U.S. and Japan home prices has been.

Figure 2



Note: per m², 5-month moving average
Sources: Bloomberg, Real Estate Economic Institute, Japan, S&P, S&P/Case-Shiller® Home Price Indices, as of Oct. 5, 2011

Obviously, just because something hasn't happened to you yet doesn't mean that it won't. Why that isn't obvious to more risk managers is a mystery to the authors.

Silo risk management allows my firm to choose the "best of breed" risk model for our silo.

Alan Greenspan, former Chairman of the Board of Governors of the Federal Reserve, made an important confession in this quote from the Guardian, five weeks after the collapse of Lehman Brothers, on October 23, 2008: "I made a mistake in presuming that the self-interests of organizations, specifically banks and others, were such that they were best capable of protecting their own shareholders and their equity in the firms," In the same manner, management of large financial institutions often ignores the fact that their staff acts in their own best interests, with the best interests of the organization being a secondary consideration at best. How else to explain why institutions often use separate and inconsistent risk systems for market risk, credit risk, liquidity risk, interest rate risk, capital allocation, and so on? Using today's financial and computer technology, there is no systems or financial theory reason for such systems to be separate and distinct.

Disparate risk management units almost never cooperate in consolidating risk systems, even when there's an obvious increase in accuracy in risk assessment, unless it's forced from the top down. With the recent decline in U.S. home prices driving all of these silo risks, using a suite of separate risk systems (most of which could not analyze home prices as a risk factor) does nothing for the shareholders but it builds barriers which preserve the independence of silo risk management organizations.

I don't care what's wrong with the model. Everyone else is using it.

One of the authors gave a presentation to the European meeting of the International Association of Credit Portfolio Managers in Zurich in May, 2007, just as the credit crisis was beginning to become obvious to more people. The thrust of the presentation was that the commonly used copula method for valuation of collateralized debt obligations gave dramatically more optimistic valuations than an alternative approach (the "reduced form approach"), in which a series of key macro factors are common drivers of default probabilities for each reference name. After the presentation, two bankers illustrated the accuracy of Keynes' quote above by saying "That was a good presentation, but there were 100 people in this room and 99 of them think you're wrong." Alas, the presentation was right on the mark but the power of the conventional wisdom blinded many to their model risk.

I don't care what's wrong with the assumptions. Everyone else is using them.

In this book, we devote a lot of time to pointing out false assumptions of various models as an important part of assessing model risk. Surprisingly, many risk managers are unconcerned about false assumptions, especially if many others are using the same false assumptions. Two of the most spectacular falsehoods have to be mentioned. The first is the use of the Black model to value interest rate caps and floors, even though the Black model assumes interest rates are constant (!). The second is the assumption of the most common form of copula model for CDO valuation that every pair of reference names has the identical correlation in default risk. The lack of anxiety about the false assumptions in these two cases in particular has resulted in a lot of job losses at major financial institutions. Beware.

Mathematical models are superior to computer simulations

Consistent with Alan Greenspan's quote above, it would not be accurate to assume that the academic builders of financial models have the shareholders' interests at heart. They don't. They have their own interests at heart, and primary among those interests is to be published in prestigious academic journals as often as possible. Even the most casual reader of such journals will observe that the overwhelming majority of articles about valuation models presents a formula for an answer, not a simulation. In order to get a mathematical formula for an answer, even the best academic financial theorists are forced to make simplifying assumptions that are not accurate. Among the many such assumptions are assumptions that a variable is normally distributed when it's not, assumptions that returns from period to period are independent when they're not, and the assumption that the number of risk factors that determine risk are small in number (1, 2 or 3) when in fact that's not the case.

A common theme in this book is that such simplifications have caused many institutions to fail and many risk managers to lose their jobs. A realistic simulation that has no "closed form" mathematical solution is usually the only accurate way to describe risk accurately. Sadly, such a simulation will normally not be published in a prestigious academic finance journal.

Big North American and European banks are more sophisticated than other banks around the world and we want to manage risk like they do

In spite of the second $1 trillion bail-out of U.S. financial institutions in the last 25 years, many persist in the hallucination that large North American and European financial institutions are the most skilled risk managers in the world. This hallucination persists in spite of a mass of public evidence to the contrary. Two quotes with respect to Citigroup in the aftermath of the credit crisis illustrate the point quite well. The New York Times (November 22, 2008) summarized the risk management expertise of top management at Citigroup with this quote:

> "Chuck Prince going down to the corporate investment bank in late 2002 was the start of that process,' a former Citigroup executive said of the bank's big C.D.O. push. 'Chuck was totally new to the job. He didn't know a C.D.O. from a grocery list, so he looked for someone for advice and support. That person was Rubin. And Rubin had always been an advocate of being more aggressive in the capital markets arena. He would say, 'You have to take more risk if you want to earn more.' "

A separate quote in Fortune (November 28, 2007) by Robert Rubin makes the point even more strongly: "I tried to help people as they thought their way through this. Myself, at that point, I had no familiarity at all with CDOs."

Besides this evidence, there are the public records of the bail-outs of Citigroup, Bank of America, Merrill Lynch, Bear Stearns, Royal Bank of Scotland, HBOS, and a host of European institutions. Why does the belief persist that North American and European institutions are the world's best risk managers? Our view is that management teams in many countries are much more sophisticated about risk management on a day to day basis than American banks were in the credit crisis. Working with risk managers in 32 countries, we see this differential in expertise on a daily basis.

Goldman says they do it this way and that must be right

The authors continue to be astonished that many financial market participants believe the modeling approach described to them by the local salesman for a big Wall Street firm. Salomon Brothers' use of financial model discussions in the mid-1980s in Tokyo was a legendary example of how to do what Wall Street does, fleecing clients by building up a "relationship" about financial models in which naïve buy-side clients reveal their proprietary modeling approach in trade for hearing about Salomon's "proprietary" yen fixed income models. In reality, the modeling conversation was strictly to exploit the clients' naiveté by model arbitrage. Total profits in Tokyo for Salomon during this time averaged more than $500 million per year for more than a decade. Model arbitrage was at the heart of the CDO losses on Wall Street, with an interesting twist. Many traders arbitraged their own firms, then moved on when the game ended. It's important to remember that Wall Street and Wall Street traders have the same "relationship" with clients that you have with a hamburger at McDonalds.

Selected Events in the Credit Crisis

As the credit crisis recedes into history, leaving only U.S. and European government deficits behind, it is important to record the credit crisis history before it's lost. This section summarizes recent events to confirm the accuracy of the assertions above. In the chapters that follow, we describe an approach to risk management designed to protect our readers from the kinds of events that unfolded in the credit crisis.

The credit crisis chronology below was assembled from many sources:

- A contemporaneous set of press clippings and news articles maintained by Kamakura Corporation from the very early dates of the credit crisis
- A credit risk chronology maintained by the Federal Reserve Bank of St. Louis
- A credit risk chronology maintained by the University of Iowa. We would like to thank @bionicturtle via twitter for bringing this chronology to our attention
- The "Levin report," released by Senator Carl Levin on April 13, 2011.

The full citation for the Levin report is as follows:

> Wall Street and the Financial Crisis: Anatomy of a Financial Collapse, Majority and Minority Staff Report, Permanent Subcommittee on Investigations, United States Senate, April 13, 2011.

This list is an abridged version of a longer chronology on www.kamakuraco.com listed in the reference section.

September 2, 2004	Washington Mutual chief risk officer Jim Vanasek sends internal Washington Mutual memo stating "At this point in the mortgage cycle with prices having increased far beyond the rate of increase in personal incomes, there clearly comes a time when prices must slow down or perhaps even decline." (Source: Levin report, page 66)
May 31, 2005	"Fed Debates Pricking the U.S. Housing Bubble," New York Times. (Source: Levin report, page 272).
June 3, 2005	"Yale Professor Predicts Housing Bubble Will Burst," National Public Radio. (Source: Levin report, page 272).
June 16, 2005	"The global housing boom: In come the waves. The worldwide rise in house prices is the biggest bubble in history. Prepare for the economic pain when it pops." The Economist.
September 30, 2005	Case-Shiller home price index for Boston, MA peaks. (Source: Standard & Poor's)
April 30, 2006	In an April memo discussing Countrywide's issuance of subprime 80/20 loans, which are loans that have no down payment and are comprised of a first loan for 80% of the home's value and a second loan for the remaining 20% of value, resulting in a loan to value ratio of 100%, Countrywide CEO Angelo Mozilo wrote "In all my years in the business I have never seen a more toxic pr[o]duct." (Source: Levin report, page 232).
May 2, 2006	Ameriquest Mortgage closes retail branch network and lays off 3,600 employees (source: Orange County Register)
May 5, 2006	Merit Financial Inc. files for bankruptcy (Source: SeattlePI)
July 31, 2006	Case-Shiller home price index for 20-city Composite Index peaks. (Source: Standard & Poor's)
August 31, 2006	Case-Shiller home price index for Las Vegas peaks. (Source: Standard & Poor's)

September 30, 2006	Case-Shiller home price index for Los Angeles peaks. (Source: Standard & Poor's)
October 31, 2006	S&P director notes in an internal e-mail "note also the 'mailing in the keys and walking away' epidemic has begun." (Source: Levin report, page 268).
December 13, 2006	Dan Sparks informed the Firm-Wide Risk Committee of Goldman Sachs that two more subprime originators had failed in the last week and that there was concern about early payment defaults, saying "Street aggressively putting back early payment defaults to originators thereby affecting the originators business. Rumors around more failures in the market." (Source: Levin report, page 478).
January 31, 2007	By January 2007, nearly 10% of all subprime loans were delinquent, a 68% increase from January 2006. (Source: Levin report, page 268).
February 2, 2007	Dan Sparks reported to senior Goldman Sachs executives "The team is working on putting loans in the deals back to the originators (New Century, Wamu, and Fremont, all real counterparties) as there seem to be issues potentially including some fraud at origination…" (Source: Levin report, page 484).
February 22, 2007	HSBC fires head of its US mortgage lending business as losses reach $10.5 billion
April 2, 2007	New Century, subprime lender, declares bankruptcy (source: Bloomberg, Levin report, page 47)
June 17, 2007	Two Bear Stearns subprime hedge funds collapse (Source: Levin report, page 47)
July 6, 2007	UBS fires CEO and the heir apparent for Chairman of the Board Peter Wuffi (Source: www.ft.com)
July 9, 2007	Credit Suisse releases a report that shows overall market CDO losses could total up to $52 billion (Source: www.bloomberg.com)

August 2, 2007	Bailout of IKB Deutsche Industriebank AG due to losses of up to one billion Euros on mortgage-related CDOs (source: Bloomberg)
August 3, 2007	AXA rescues money market funds after subprime losses (source: Reuters)
August 9, 2007	BNP freezes $2.2 billion of funds over subprime (source: Reuters, Bloomberg)
August 14, 2007	17 Canadian structured investment vehicles fail when commercial paper is denied by Canadian banks (source: Bloomberg)
August 16, 2007	Countrywide taps $11.5 billion commercial paper back up line (source: Bloomberg)
September 14, 2007	Bank of England rescues Northern Rock over U.K. mortgage losses (source: Reuters)
October 1, 2007	UBS announces a $3.7 billion write-down and, after the announcement, the chief executive of its investment banking division Huw Jenkins was replaced (Source: www.ft.com).
October 5, 2007	Merrill Lynch writes down $5.5 billion in losses on subprime investments (source: Reuters)
October 16, 2007	Citigroup announces $3 billion in write-offs on subprime mortgages (Source: www.ft.com)
October 18, 2007	Bank of America writes off $4 billion in losses (source: Bloomberg)
October 24, 2007	Merrill Lynch writes down $7.9 billion on subprime mortgages and related securities (source: Bloomberg, www.ft.com)
October 30, 2007	Merrill Lynch CEO O'Neal fired (source: Reuters)
November 5, 2007	Citigroup CEO Prince resigns after announcement that Citigroup may have to write down as much as $11 billion in bad debt from subprime loans. (Source: Bloomberg)

November 7, 2007	Morgan Stanley reports $3.7 billion in subprime losses (source: Bloomberg)
November 13, 2007	Bank of America says it will have to write off $3 billion in bad debt (Source: http://news.bbc.co.uk)
November 15, 2007	Barclays confirms a $1.6 billion write down in the month of October on their subprime holdings. The bank also released that more than £5 billion in exposure to subprime loan packages could lead to more write downs in the future (Source: Bloomberg)
November 21, 2007	Freddie Mac announces $2 billion in losses from mortgage defaults (Source: www.ft.com)
December 6, 2007	The Royal Bank of Scotland announces that it expects to write down 1.25 billion pounds sterling because of exposure to the U.S. subprime market. (Source: http://news.bbc.co.uk)
December 10, 2007	UBS announces another $10 billion in subprime write-downs, bringing the total to date to $13.7 billion. UBS also announced a capital injection of $11.5 billion from the government of Singapore and an unnamed Middle East investor. (Source: www.marketwatch.com)
December 12, 2007	Federal Reserve establishes Term Auction Facility to provide bank funding secured by collateral (Source: Levin report, page 47)
December 19, 2007	Morgan Stanley announces $9.4 billion in write-downs from subprime losses and a capital injection of $5 billion from a Chinese sovereign wealth fund. (Source: www.ft.com)
January 15, 2008	Citigroup reports a $9.83 loss in the fourth quarter after taking $18.1 billion in write-downs on subprime mortgage-related exposure. The firm also announced it would raise $12.5 billion in new capital, including $6.88 billion from the Government of Singapore Investment Corporation. (Source: www.ft.com)
January 17, 2008	Merrill Lynch announces net loss of $7.8 billion for 2007 due to $14.1 billion in write-downs on investments related to subprime mortgages. (Source: http://news.bbc.co.uk)

January 22, 2008	Ambac reports a record loss of $3.26 billion after write downs of $5.21 billion on its guarantees of subprime mortgage-related bonds. Source: (www.ft.com)
February 14, 2008	UBS confirmed a 2007 loss of $4 billion on $18.4 billion in write downs related to the subprime crisis.
February 17, 2008	Britain announces the nationalization of Northern Rock, with loans to Northern Rock reaching 25 billion pounds sterling. (Source: www.ft.com)
February 28, 2008	AIG announces a $5.2 billion loss for the fourth quarter of 2007, its second consecutive quarterly loss. AIG announced write-downs of $11.12 billion pretax on its credit default swap portfolio. (Source: www.ft.com)
March 3, 2008	HSBC, the largest UK bank, reports a loss of $17.2 billion in write downs of its U.S. mortgage portfolio (Source: BBC News).
March 14, 2008	Federal Reserve and JPMorgan Chase agree to provide emergency funding for Bear Stearns. Under the agreement, JPMorgan would borrow from the Federal Reserve discount window and funnel the borrowings to Bear Stearns (Source: Forbes and www.datacenterknowledge.com).
March 16, 2008	JPMorgan Chase agrees to pay $2 per share for Bear Stearns on Sunday, March 16, a 93% discount to the closing price on Friday March 14. JPMorgan agreed to guarantee the trading liabilities of Bear Stearns, effective immediately (Source: New York Times).
April 1, 2008	UBS, whose share price fell 83% in the last year, reports it will write down $19 billion in the first quarter on its U.S. holdings (Source: Financial Times).
April 1, 2008	UBS CEO Ospel resigns after announcement that UBS total losses are almost $38 billion (Source: Bloomberg).
April 18, 2008	Citigroup reports $5.11 billion in first quarter losses and $12 billion in write downs on subprime mortgage loans and other risky assets. The bank plans to cut 9,000 jobs

in addition to the 4,200 jobs cut in January (Source: BBC News).

May 9, 2008	AIG reports $7.81 billion in first quarter losses and $9.11 billion of write downs on the revaluation of their credit default swap portfolio. AIG Holding Company was also downgraded to AA- by two major rating agencies (Source:http://seekingalpha.com/article/76590-american-international-group-inc-q1-2008-earnings-call-transcript).
June 2, 2008	Wachovia CEO Thompson is ousted following large losses that resulted from the acquisition of a big mortgage lender at the peak of the housing market (Source: Reuters).
June 25, 2008	Shareholders of Countrywide, a troubled mortgage lender, approve the acquisition of the company by Bank of America (Source: Financial Times).
July 11, 2008	IndyMac Bank, a $30 billion subprime mortgage lender fails and is seized by FDIC (Source: Levin report, page 47 and page 234) after depositors withdraw $1.55 billion.
July 17, 2008	Merrill Lynch writes down $9.4 billion on mortgage related assets (Source: Financial Times).
July 19. 2008	Citigroup lost $5.2 billion and had $7.2 billion of write downs in the second quarter (Source: Financial Times).
July 22, 2008	Marking the largest loss in the history of the fourth largest U.S. bank, Wachovia loses $8.9 billion in the second quarter (Source: Financial Times).
September 7, 2008	U.S. takes control of Fannie Mae & Freddie Mac (Source: Levin report, page 47). The two companies currently have $5400 billion in outstanding liabilities and guarantee three-quarters of new U.S. mortgages. The government agreed to inject up to $100 billion in each of them and will buy mortgage backed bonds (Source: Financial Times).
September 11, 2008	Lehman Brothers reports its worst ever third quarter as it lost $3.9 billion total and $7.8 billion in credit linked write downs. The company plans to shrink its size (Source: Financial Times).

September 13, 2008	The U.S. Treasury and Federal Reserve refuse to provide public funds to help with a rescue takeover for Lehman Brothers as they did for Bear Sterns. Bank of America backs out of negotiations with Lehman Brothers because of the lack of government funds (Source: Financial Times).
September 15, 2008	Lehman Brothers bankruptcy (Source: Levin report, page 47).
September 15, 2008	Merrill Lynch announces sale to Bank of America (Source: Levin report, page 47).
September 16, 2008	Federal Reserve offers $85 billion credit line to AIG; Reserve Primary Money Fund NAV falls below $1 (Source: Levin report, page 47).
September 18, 2008	Lloyds rescues HBOS, the largest mortgage lender in the UK (Source: Reuters).
September 21, 2008	Goldman Sachs and Morgan Stanley convert to bank holding companies (Source: Levin report, page 47).
September 25, 2008	Washington Mutual fails, subsidiary bank is seized by the FDIC and sold to JPMorgan Chase for $1.9 billion. JPMorgan Chase immediately wrote off $31 billion in losses on the Washington Mutual assets. (Source: The Guardian and Levin report, page 47).
October 3, 2008	Congress and President Bush establish Troubled Asset Relief Program (TARP), which is created by the Emergency Economic Stabilization Act (EESA) (Source: Levin report, page 47, SIGTARP report, page 2). The revised bailout plan allows the Treasury to restore stability to the financial system by buying $700 billion in toxic debt from banks (Source: CNN).
October 4, 2008	Wells Fargo offers $15.1 billion to buy Wachovia, outbidding Citigroup's $2.2 billion bid (Source: Financial Times).
October 6, 2008	Germany announces €50 billion bail-out of Hypo Real Estate AG (Source: USAToday).

October 6, 2008	Germany announces unlimited guarantee of €568 billion in private bank deposits (Source: USAToday).
October 8, 2008	The UK government implements £400 billion rescue plan that includes government investing in banking industry, guaranteeing up to £250 billion of bank debt, and adding £100 billion to the Bank of England's short-term loan scheme (Source: Financial Times).
October 13, 2008	The UK government injects £37 billion in the nation's three largest banks, kicking off the nationalization process (Source: Financial Times).
October 14, 2008	The U.S. government announces capital injection of $250 billion, of which $125 billion will go to 9 large banks as part of the Capital Purchase Program (CPP) in exchange for more government control on items such as executive compensation (Source: Financial Times, SIGTARP report, page 1).
October 16, 2008	Switzerland government gives UBS a $59.2 billion bailout (Source: Bloomberg).
October 28, 2008	U.S. uses TARP to buy $125 billion in preferred stock at 9 banks (Source: Levin report, page 47). The 9 banks held over $11 trillion in banking assets or roughly 75% of all assets owned by U.S. banks (Source: SIGTARP report, page 1).
November 23, 2008	U.S. gives government bailout to Citigroup, agreeing to cover losses on roughly $306 billion of Citigroup's risky assets (Source: Reuters).
December 18, 2008	President George W. Bush reveals plan to rescue General Motors and Chrysler by lending them a total of $17.4 billion (Source: Financial Times).
January 15, 2009	The U.S. government gives Bank of America an additional $20 billion as part of TARP's Targeted Investment Program (TIP), which allows the Treasury to make additional targeted investments than what was given under TARP's Capital Purchase Program (Source: SIGTARP report, page 1). Furthermore, the government

	agrees to guarantee nearly $118 billion of potential losses on troubled assets (Source: Financial Times).
March 20, 2009	German parliament passes Hypo Real Estate Nationalization bill (Source: Deutsche Welle)
September 12, 2010	German government adds another €50 billion in aid to Hypo Real Estate AG bringing total support to €142 billion (Source: Business Standard).