"Kill All The Quants"?: Models vs. Mania in the Current Financial Crisis

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Andrew W. Lo

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MIT Sloan School of Management

I.E. Block Lecture 2009

July 8, 2009

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Summary of the Crisis

What Happened?

- Late 1990's: low interest rates, "ownership society", housing boom
- Lots of mortgages issued due to ARMs, securitization, Fannie, Freddie
- Lots of investors holding MBS (thanks to AAA ratings and CDS)
- Many of these securities were leveraged (AAA ratings and CDS)
- 2004: interest rates rise; 2006: housing market declines, defaults begin
- Losses are magnified by securitization, leverage, illiquidity
- Securities are downgraded, collateral deteriorates, firesales
- Investors, dealers, insurers, originators, GSEs lose money
- Loss of confidence triggers further losses, downgrades, more firesales
- Leads to "death spirals", reduction in credit, general flight to quality
- Regulators intervene to forestall even more serious repercussions

How Could This Have Happened To Us???

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Summary of the Crisis

"Hall of Shame"?

- Homeowners
- Commercial banks
- Investment banks and other issuers of MBSs, CDOs, and CDSs
- Mortgage lenders, brokers, servicers, trustees
- Credit rating agencies (S&P, Moody, Fitch)
- Insurance companies (multiline, monoline)
- Investors (hedge funds, pension funds, mutual funds, other institutions)
- Regulators (SEC, OCC, CFTC, Fed, etc.)
- Government sponsored enterprises
- Politicians

But What About The "Quants"? Models vs. Mania

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Summary of the Crisis

"Confessions of a Risk Manager" in *The Economist*, August 7, 2008:

> Like most banks we owned a portfolio of different tranches of collateralised-debt obligations (CDOs), which are packages of asset-backed securities. Our business and risk strategy was to buy pools of assets, mainly bonds; warehouse them on our own balance-sheet and structure them into CDOs; and finally distribute them to end investors. **We were most eager to sell the non-investment-grade tranches, and our risk approvals were conditional on reducing these to zero.** We would allow positions of the top-rated AAA and super-senior (even better than AAA) tranches to be held on our own balance-sheet as the default risk was deemed to be well protected by all the lower tranches, which would have to absorb any prior losses.

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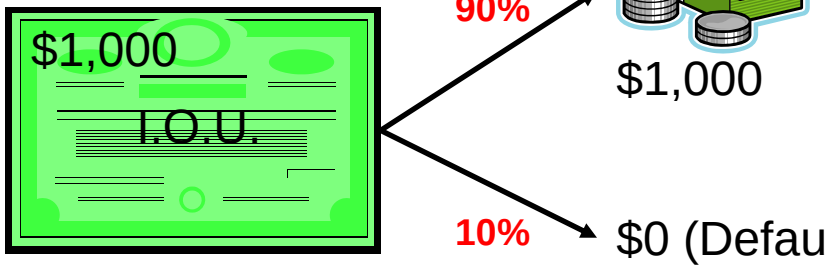
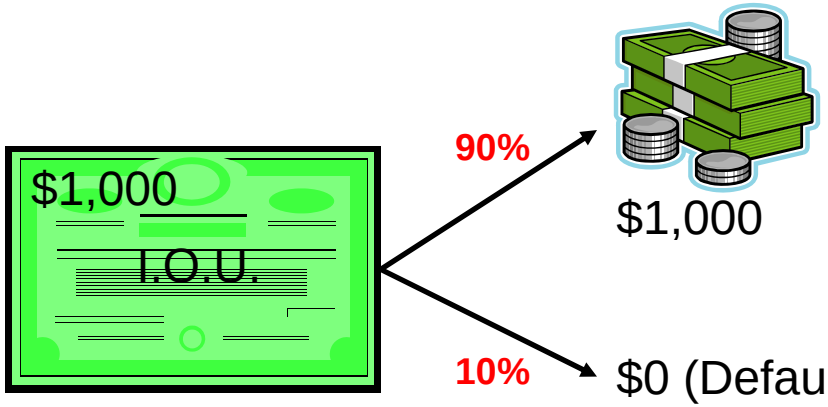
Securitization

Consider Simple Securitization Example:



Price = 90% × $1,000 + 10% × $0
= $900



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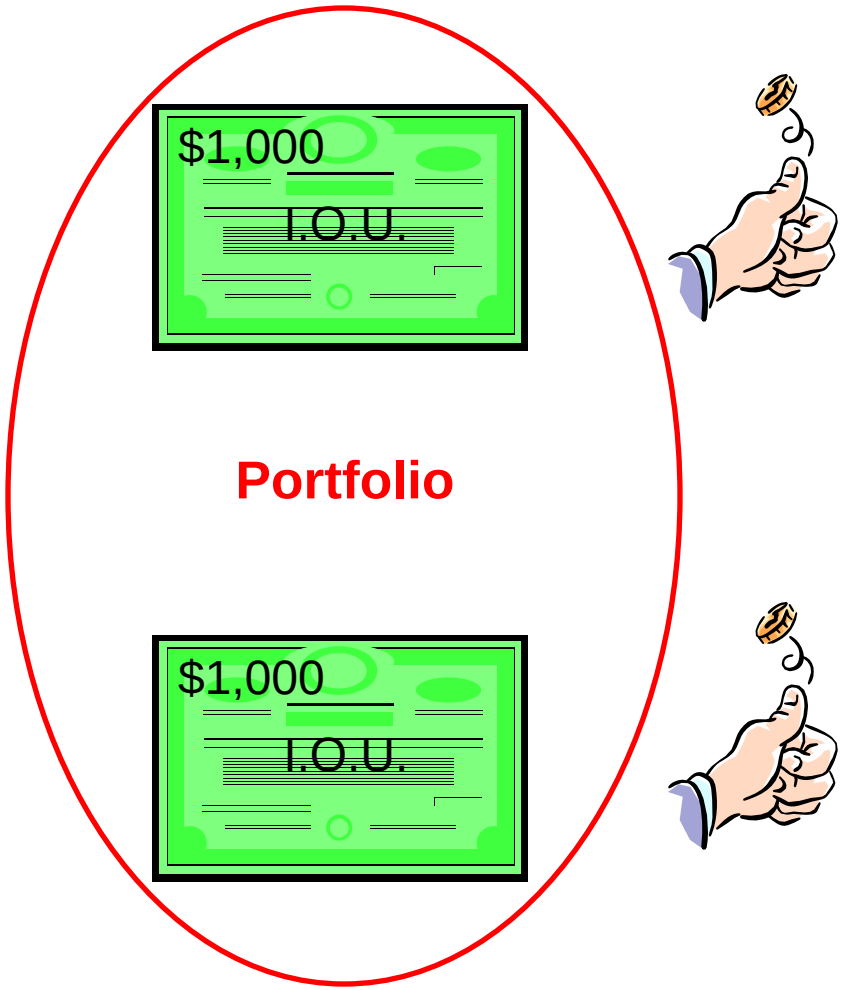
Securitization



Assuming
Independent Defaults

Portfolio Value	Prob.
$2,000	81%
$1,000	18%
$0	1%

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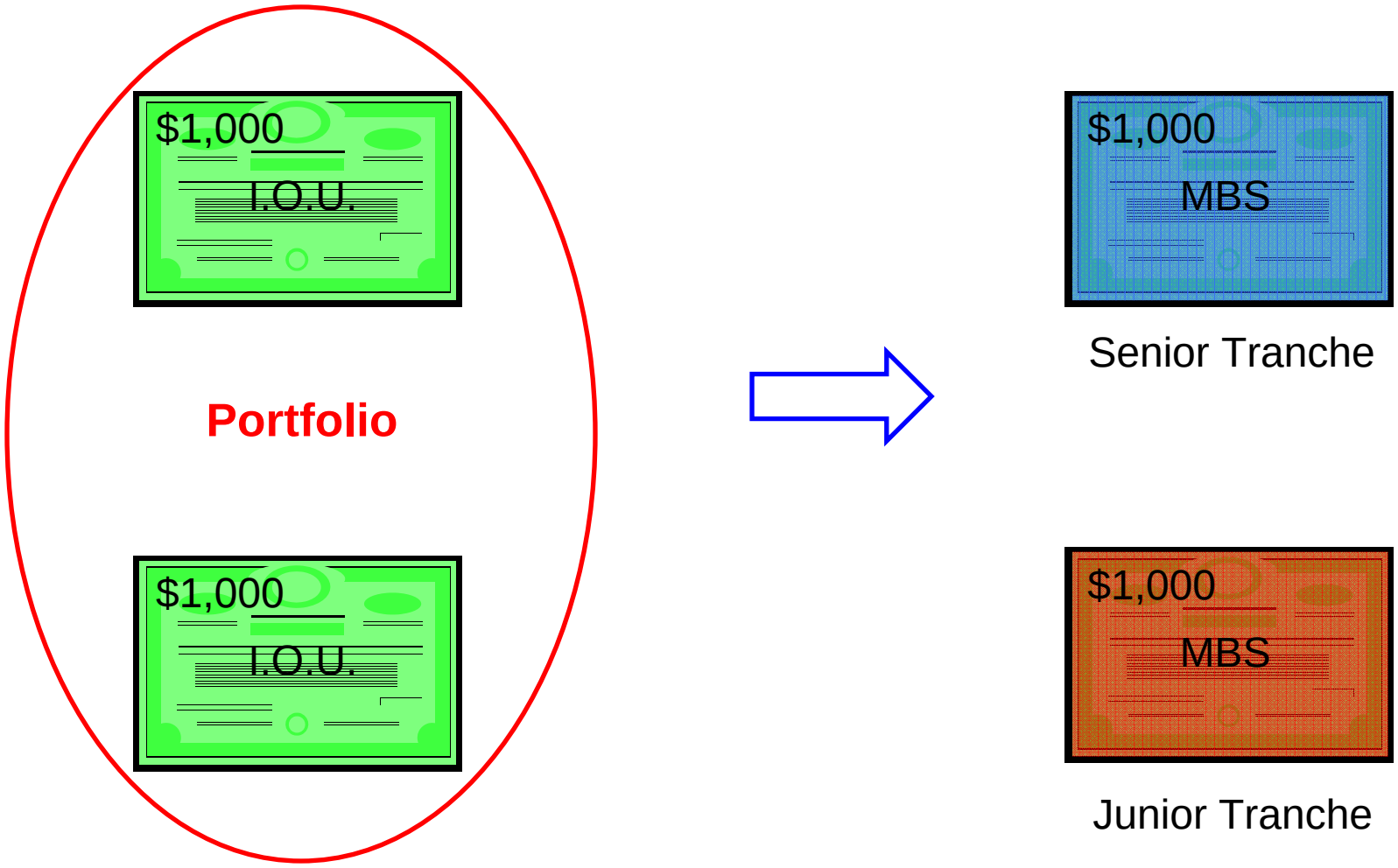
Securitization



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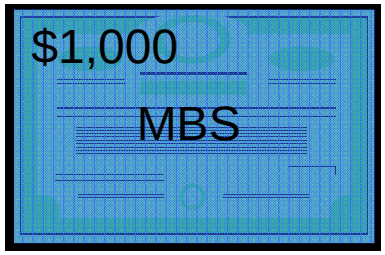
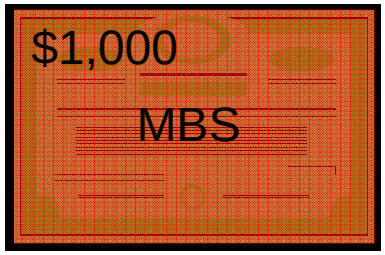


Senior Tranche



Junior Tranche

Assuming Independent Defaults

Portfolio Value	Prob.	Senior Tranche	Junior Tranche
$2,000	81%	$1,000	$1,000
$1,000	18%	$1,000	$0
$0	1%	$0	$0

Bad State For Senior Tranche (1%)

Bad State For Junior Tranche (19%)

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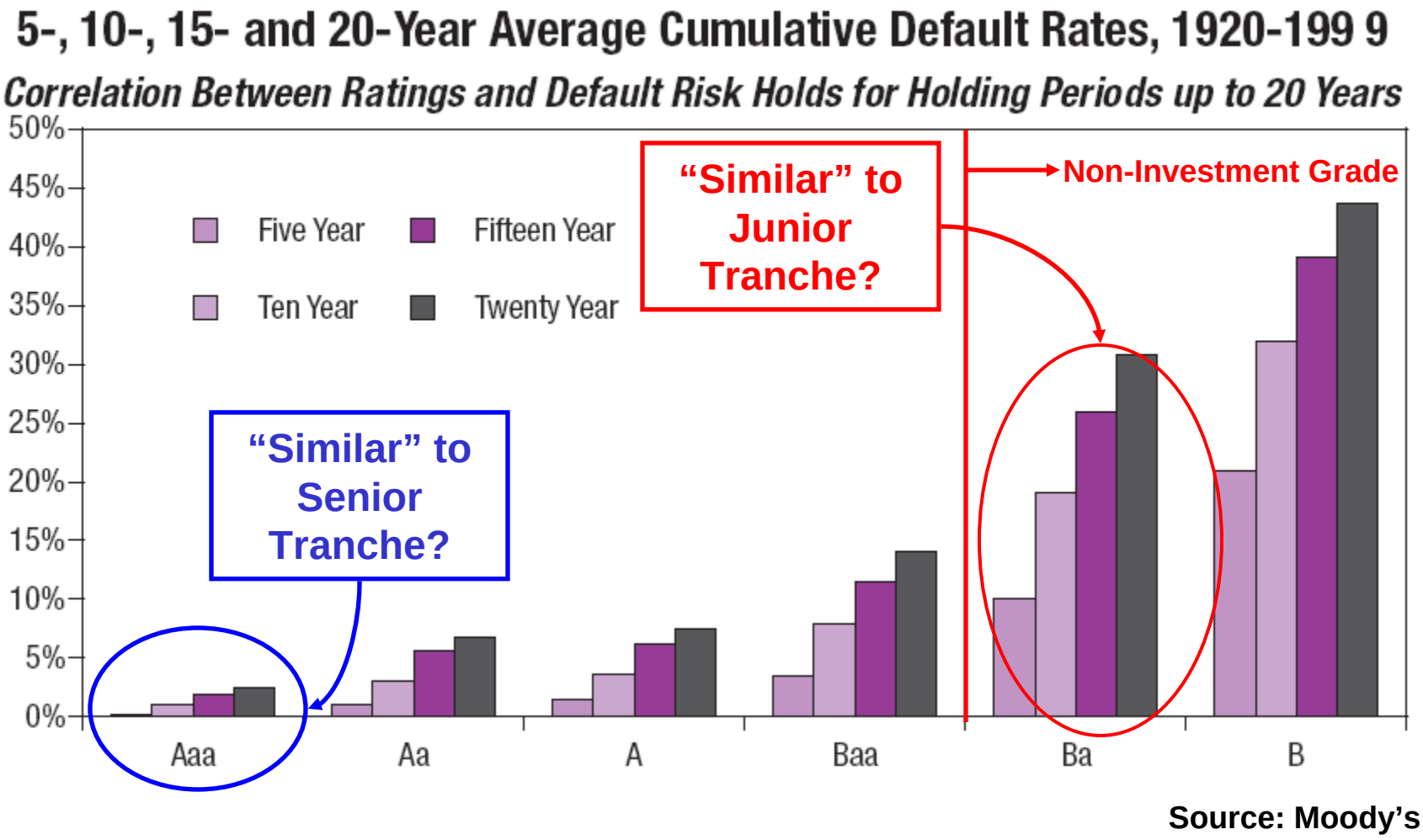
Securitization



Source: Moody's

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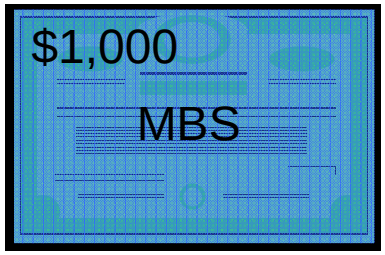
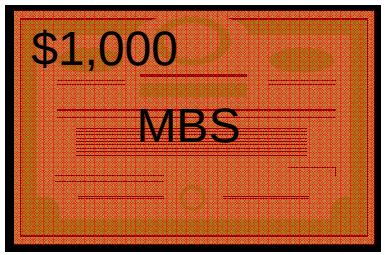


Senior Tranche



Junior Tranche

Assuming Independent Defaults

Portfolio Value	Prob.	Senior Tranche	Junior Tranche
$2,000	81%	$1,000	$1,000
$1,000	18%	$1,000	$0
$0	1%	$0	$0

Price for Senior Tranche = 99% × $1,000 + 1% × $0
= $990

Price for Junior Tranche = 81% × $1,000 + 19% × $0
= $810

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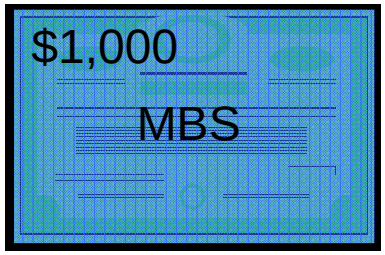
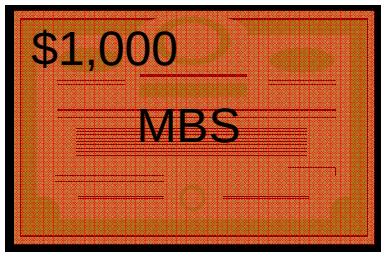


Senior Tranche



Junior Tranche

Assuming Independent Defaults

Portfolio Value	Prob.	Senior Tranche	Junior Tranche
$2,000	81%	$1,000	$1,000
$1,000	18%	$1,000	$0
$0	1%	$0	$0

But What If Defaults Become Highly Correlated?

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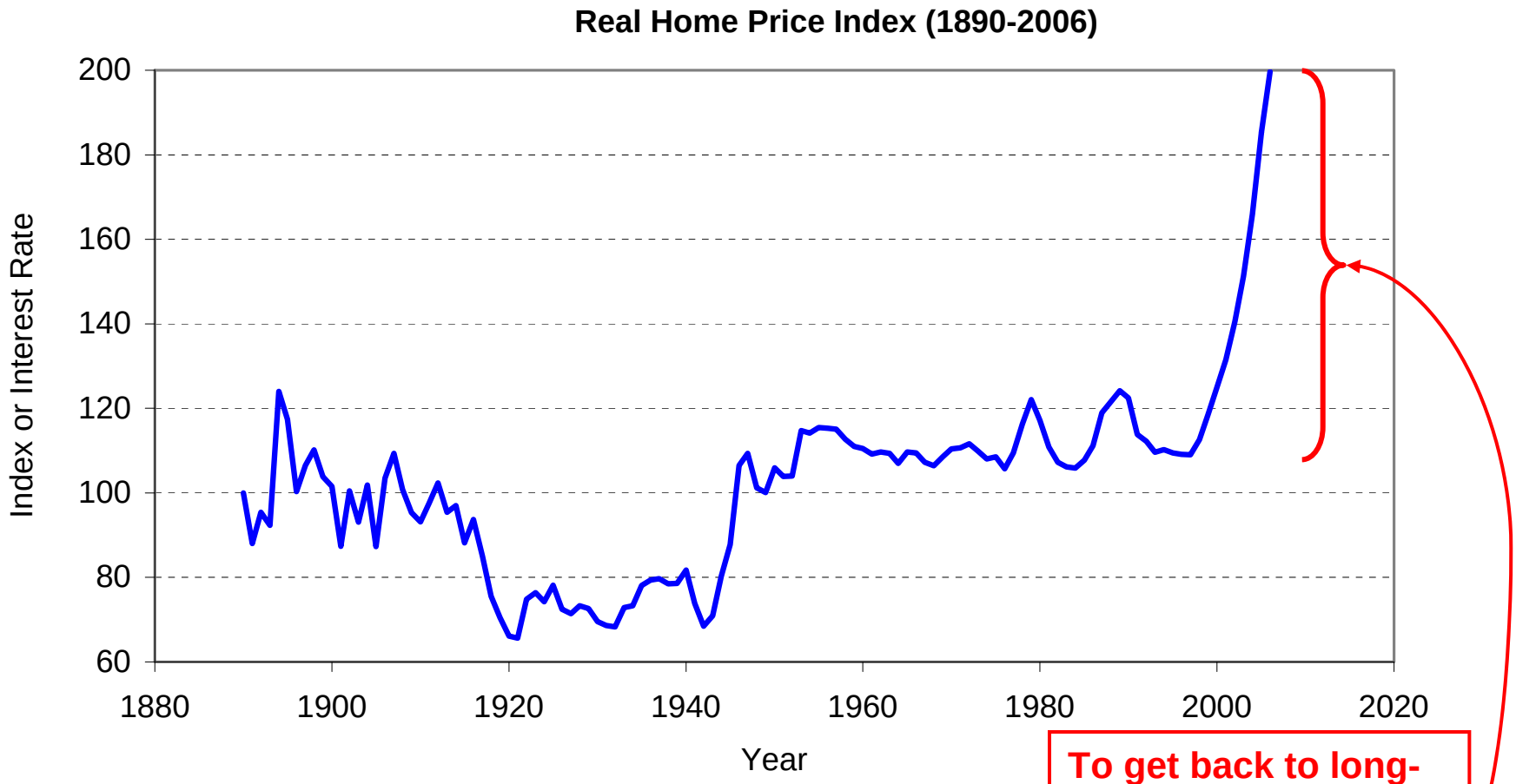

Source: Robert J. Shiller, Irrational Exuberance, 2nd. Edition.
David Geltner, 2008.

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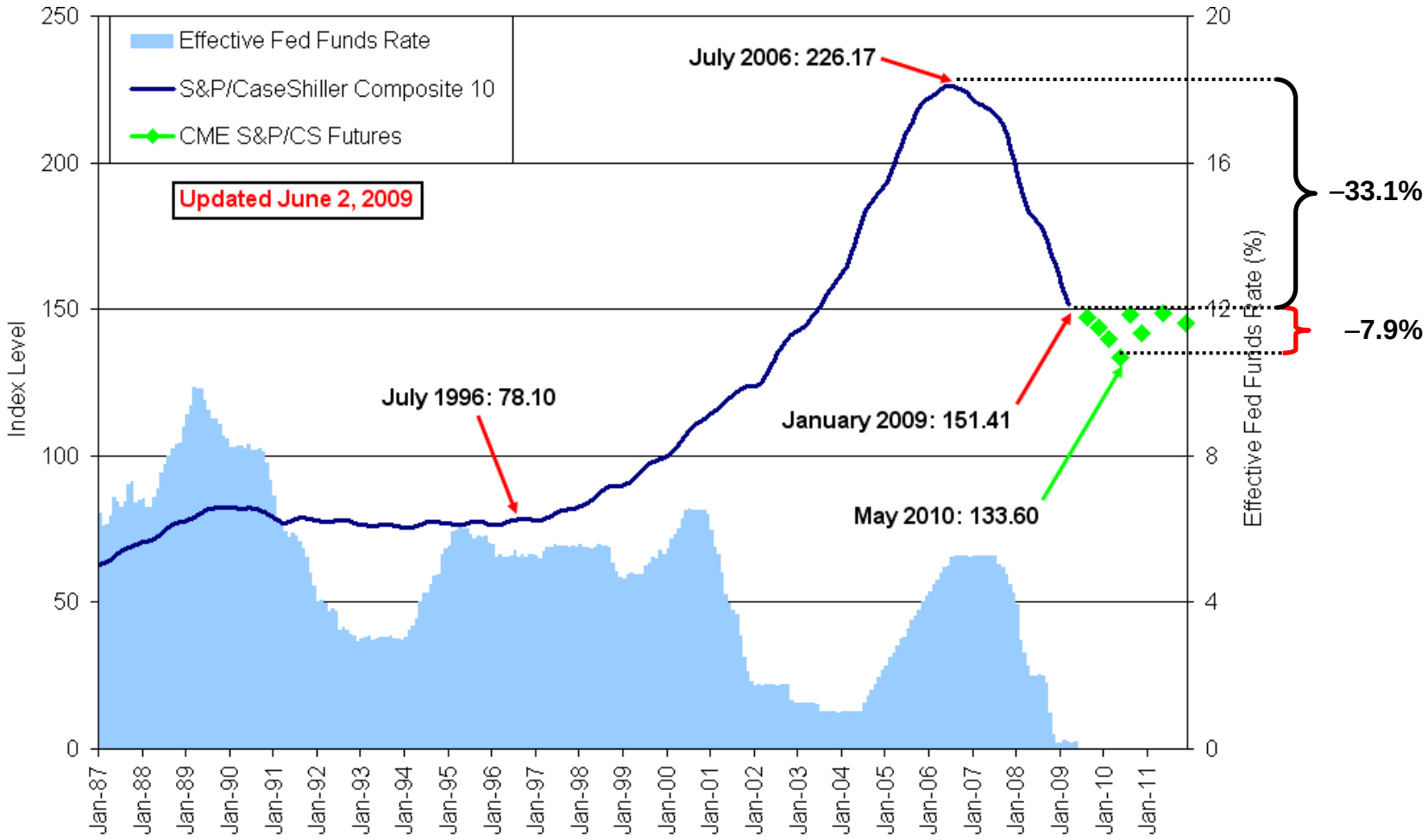
Securitization

S&P/Case Shiller Composite 10 Home Price Index



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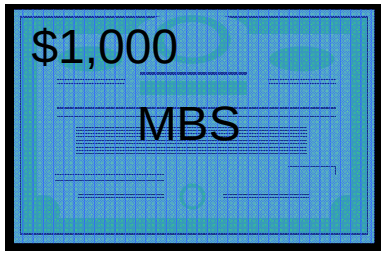
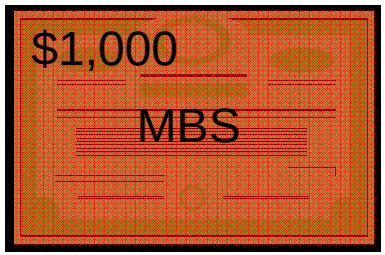


Senior Tranche



Junior Tranche

Assuming Perfectly Correlated Defaults

Portfolio Value	Prob.	Senior Tranche	Junior Tranche
$2,000	90%	$1,000	$1,000
$0	10%	$0	$0

Bad State For Senior Tranche (10%)

Bad State For Junior Tranche (10%)

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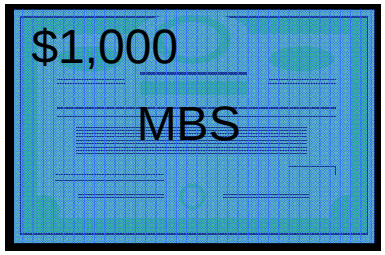
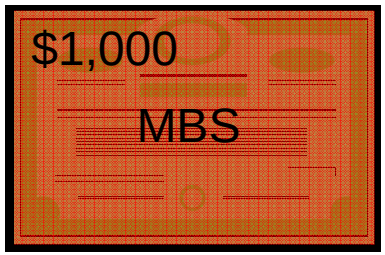


Senior Tranche



Junior Tranche

Assuming Perfectly Correlated Defaults

Portfolio Value	Prob.	Senior Tranche	Junior Tranche
$2,000	90%	$1,000	$1,000
$0	10%	$0	$0

Price for Senior Tranche = 90% × $1,000 + 10% × $0
= $900 (was $990)

Price for Junior Tranche = 90% × $1,000 + 10% × $0
= $900 (was $810)

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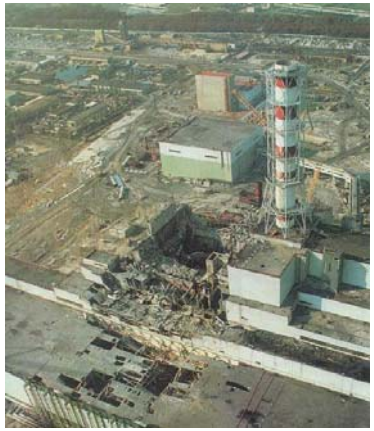
Complexity, Tight Coupling, and Human Behavior






Why Do Crises Happen In Other Industries?

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Complexity, Tight Coupling, and Human Behavior

Perrow's (1984) Theory of "Normal Accidents"

- Two conditions:
  1. Complex system (nonlinearities)
  2. Tight coupling
- Examples: nuclear power plants, chemical plants, NASA
- We should **expect** large failures under these conditions
- We should **prepare** for such failures

How Complex Are CDO's?

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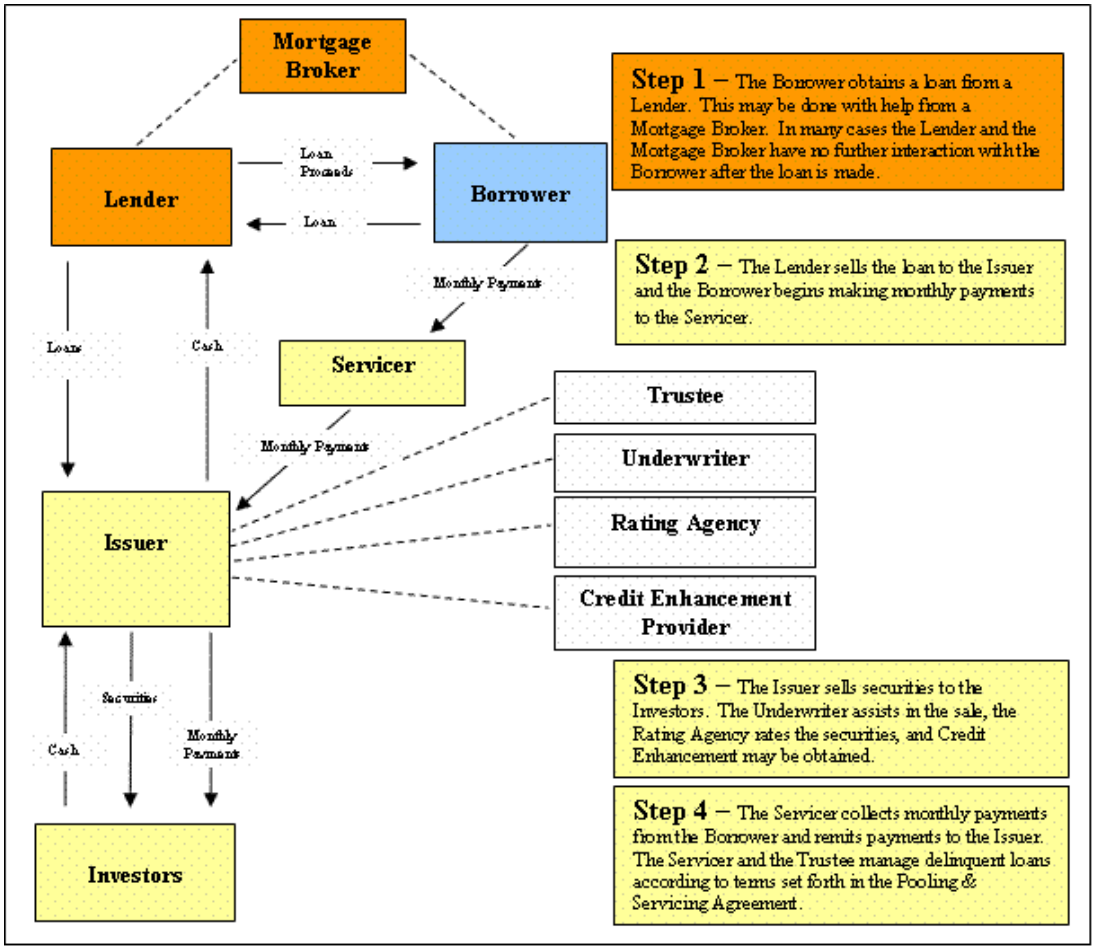
Complexity, Tight Coupling, and Human Behavior

Just How Complex Are MBSs, CDO²s, and CDSs?

- Many moving parts
  - ARMs
  - Caps
  - Penalties
  - Originator/lender
  - Other "features"
- Many parties
- Not much history
- Rapid growth



Source: http://www.fdic.gov/news/news/speeches/archives/2007/chairman/spapr1707.html

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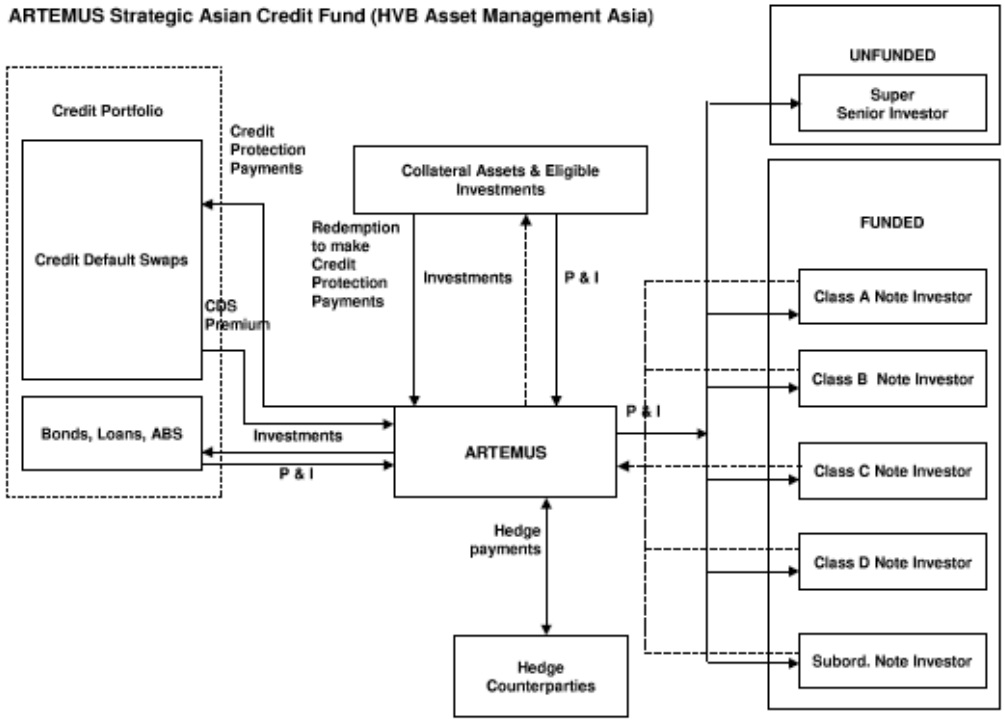
Complexity, Tight Coupling, and Human Behavior

HVB Asset Management Asia (HVBAM) has brought to market the first ever hybrid collateralized debt obligation (CDO) managed by an Asian collateral manager. The deal, on which HVB Asia (formerly known as HypoVereinsbank Asia) acted as lead manager and underwriter, is backed by $120 million of asset-backed securitization bonds and $880 million of credit default swaps... Under the structure of the transaction, Artemus Strategic Asian Credit Fund Limited—a special purpose vehicle registered in the Cayman Islands—issued $200 million of bonds to purchase the $120 million of cash bonds and deposit 80 million into the guaranteed investment contract, provided by AIG Financial Products. In addition, the issuer enters into credit default swap agreements with three counterparties (BNP Paribas, Deutsche Bank and JPMorgan) with a notional value of $880 million. On each interest payment date, the issuer, after payments of certain senior fees and expenses and the super senior swap premium, will use the remaining interest collections from the GIC accounts, the cash ABS bonds, the hedge agreements, and the CDS premiums from the CDS to pay investors in the CDO transaction ... The transaction was split into five tranches, including an unrated $20 million junior piece to be retained by HVBAM. The $127 million of A-class notes have triple-A ratings from Fitch, Moody's and S&P, the 20 million B-notes were rated AA/Aa2/AA, the $20 million C bonds were rated A/A2/A, while the $13 million of D notes have ratings of BBB/Baa2 and BBB.



Source: Bluhm (2003).

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Complexity, Tight Coupling, and Human Behavior

$$S[L] = \begin{cases} L & \text{when } L \le K_{IRB} \\ K_{IRB} + K[L] - K[K_{IRB}] + (d \cdot K_{IRB} / \omega)(1 - e^{\omega(K_{IRB} - L)/K_{IRB}}) & \text{when } K_{IRB} < L \end{cases}$$

where

$$h = (1 - K_{IRB} / LGD)^N$$

$$c = K_{IRB} / (1 - h)$$

$$v = \frac{(LGD - K_{IRB}) K_{IRB} + 0.25 (1 - LGD) K_{IRB}}{N}$$

$$f = \left(\frac{v + K_{IRB}^2}{1 - h} - c^2 \right) + \frac{(1 - K_{IRB}) K_{IRB} - v}{(1 - h)\tau}$$

$$g = \frac{(1 - c)c}{f} - 1$$

$$a = g \cdot c$$

$$b = g \cdot (1 - c)$$

$$d = 1 - (1 - h) \cdot (1 - Beta[K_{IRB}; a, b])$$

$$K[L] = (1 - h) \cdot ((1 - Beta[L; a, b]) L + Beta[L; a + 1, b] c).$$

Paragraph 624 of Basel II, June 2004, p. 132

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Complexity, Tight Coupling, and Human Behavior

Perrow's (1984) Modified Theory of "Normal Accidents"

- Three conditions:
  1. Complex system (nonlinearities)
  2. Tight coupling
  3. Third condition (Lo, 2004): Absence of negative feedback over an extended period of time

Perrow Does Not Explain Why Such Accidents Are "Normal"

⇒ **Human Behavior Is The Reason**

- Investors
- Managers
- Legislators
- Regulators

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Could The Crisis Have Been Avoided?

Source: www.viscog.com

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Could The Crisis Have Been Avoided?

What If We Knew This Was Going To Happen In 2005?

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'Irrational exuberance' -- again

Remember the stock bubble? Yale economist Robert Shiller, says we're just as mad for real estate.

January 25, 2005: 12:54 PM EST
By Robert J. Shiller

NEW YORK (MONEY Magazine) - Yale University economist Robert Shiller made one of the great calls in stock market history. His book "Irrational Exuberance" hit the shelves in March 2000, the same month the tech-stock bubble struck a sharp pin.

Related stories
- Shiller interview
- My three houses
- All the real estate stories

Timing helped turn "Irrational Exuberance" into a bestseller, but Shiller had been predicting for several years that excessive speculation would prove a disaster for many investors.

A few days before Alan Greenspan famously used the phrase "irrational exuberance" in a December 1996 speech, Shiller had been at lunch with the Fed chairman, arguing that the stock market was irrational and suggesting that Greenspan might have something to say about how overvalued it had become.

Shiller's first tome focused exclusively on the stock market. A substantially revised edition of "Irrational Exuberance", to be published in April, includes a new chapter on what Shiller believes is the bubble in residential real estate.

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Could The Crisis Have Been Avoided?

What If We Knew This Was Going To Happen In 2005?

ECONOMIC VIEW

MARK GIMEIN

Is a Hedge Fund Shakeout Coming Soon? This Insider Thinks So

F all the sectors of the financial universe, the hedge fund world is probably the most secretive and almost rtainly the most alluring. Open only to in- tutions and the wealthy, hedge funds offer phisticated models of risk, access to the st financial minds and the chance for out- ed returns. According to Van Hedge Advi- rs, hedge fund assets have topped a tril- n dollars.

The downside, unfortunately, is that occa- nally the industry may be subject to cata- rophic and unexpected losses. In 1998, any top hedge fund managers lost their irts. Long Term Capital Management me close to collapse. Just last month, in- stors were reminded of exactly this kind possibility with the apparent failure of a 00 million Connecticut hedge fund man- ed by the Bayou Group.

Andrew W. Lo, a finance professor at the oan School of Management at the Mas- chusetts Institute of Technology, has been udying hedge fund failures and risks, and s says that another hedge fund industry akeout is likely in the near future. Mr. Lo ns a company, AlphaSimplex, that man- es a $400 million hedge fund — so he is not oking for a reason to say hedge funds are trouble. But that is exactly what he's say- g, backing it up with powerful data and a uple of unexpected theories.

Mr. Lo has been working on the econom- s of hedge funds since the mid-1990's, but e started thinking seriously about how to easure risk across the industry in 1999, hen he was first approached by backers to tart his own hedge fund; it opened in 2003. le knew that sophisticated investors would ant lots of data about his fund's returns nd about the risk level he would assume, so e started looking carefully at the return ata provided by other funds.

Traditionally, economists have thought hat big up-and-down fluctuations in returns ndicated risky investments, so many hedge

Andrew W. Lo of M.I.T. says he has found warning signs for the hedge fund industry.

fund investors have hoped to see a pattern of smooth and even returns. But Mr. Lo quickly saw that lots of hedge funds were posting returns that were just too smooth to be realistic. Digging deeper, he found that funds with hard-to-appraise, illiquid investments — like real estate or esoteric interest rate swaps — showed returns that were particularly even. In those cases, he concluded, managers had no way to measure their fluctuations, and simply assumed that their value was going up steadily. The problem, unfortunately, is that those are exactly the kinds of investments that can be subject to big losses in a crisis. In 1998, investors retreated en masse from such investments.

Now, in a paper to be published by the University of Chicago, Mr. Lo, working with his graduate students, has come to a disturbing conclusion: that smooth returns, far from proving that hedge funds are safe, may be a warning sign for the industry. (The paper is at http://web.mit.edu/alo/www/Papers/systemic2.pdf.)

That doesn't necessarily hold true for every individual fund, but as Mr. Lo shows in his paper, measuring the smoothness of returns gives economists a good way to estimate the level of relatively illiquid investments in the hedge fund world. The approach lets economists measure industry-wide liquidity risks without knowing the details of the investments — information that hedge funds just don't give out.

By Mr. Lo's measures, hedge fund investments are less liquid now than they have been in 20 years. His work shows that the same pattern of investing preceded the 1998 global hedge fund meltdown and the 1987 stock market crash.

But that's not the only reason for worry. He says that crises like that of 1998 may be more predictable than was previously thought — and that another crisis is likely.

The 1998 panic is generally thought to have been set off by the Russian government's default on its debt. But Mr. Lo points out that only a minuscule proportion of the world's hedge fund investments were in Russian government bonds.

In his paper, he shows that the catastrophic losses of 1998 were preceded by a noticeable series of months of mediocre performance. Mr. Lo argues that while a hedge fund crisis appears to be sudden and to be caused by unforeseen events, the breakdown is only the late stage of the problem. As more hedge funds compete for the same slice of the pie, he says, their managers feel that they have no choice but to "leverage up," juicing their returns by borrowing more money to make bigger investments.

That, in turn, makes the investments more prone to a sudden credit crisis. Hedge funds that are highly leveraged are vulnerable to having their lenders — banks and big brokerage firms — cut off credit when they think that their money may be at risk. And Mr. Lo thinks that lenders would do exactly that in an industrywide downturn. That would force hedge funds to close out their positions at the worst possible time — the kind of cycle that brought down Long Term Capital Management.

Here again, his data suggests that the current situation is serious. His research indicates that the industry may have already entered a period of lower returns that signal a prelude to crisis. He points to a downturn in April that hit virtually every category of hedge fund pursuing every kind of strategy.

"The concern that I and others have is that we're approaching the perfect financial storm where all the arrows line up in one direction," Mr. Lo said. The more money that is invested in hedge funds, he said, "the bigger the storm will be."

What might set off a crash is a matter of guesswork. Mr. Lo thinks that an oil-price increase to $100 a barrel, a level predicted by one Goldman Sachs analyst, could do it. Or , he said, a tightening of lending rules at Fannie Mae, the mortgage giant, could set off a "humongous unwinding" in credit markets. But Mr. Lo, who refers to some of his research as "measuring how strong the camel's back is and how much straw is already on it," thinks that the spark could be something much smaller.

ALREADY, his work has prompted hedge fund managers and investors to pay more attention to the hidden risks of funds that seem to be performing quite well. Clifford S. Asness, managing principal at AQR Capital Management, a large and successful hedge fund based in Greenwich, Conn., says Mr. Lo's work forces fund managers in general to confront the risks: "He demonstrates simple models that generally show a winning payoff but occasionally really die."

So what should be done? Mr. Lo sees no way to eliminate the cyclical nature of hedge fund investing, but he says we can learn from the mistakes of funds that fail. He advocates the creation of a financial equivalent of the teams at the National Transportation Safety Board that swoop in to investigate airplane crashes.

The nightmare script for Mr. Lo would be a series of collapses of highly leveraged hedge funds that bring down the major banks or brokerage firms that lend to them. That's a possibility that the entire hedge fund industry — secretive and fractious though it is — has a huge interest in avoiding. □

THE NEW YORK TIMES, SUNDAY, SEPTEMBER 4, 2005

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Could The Crisis Have Been Avoided?

What If We Knew This Was Going To Happen In 2005?

- Through what mechanism can this information be acted on?
  - As CEO, reduce business exposure ⇒ lose market share
  - As CRO, hedge exposure ⇒ lose money until 2007
  - As portfolio manager, turn away assets ⇒ lose key personnel
- Success and prosperity are potent anesthetics ("feeling no pain")
- But pain is necessary to guard against dangers
- Prolonged bull market dulls the sense of danger and risk aversion
- But why not exit when initial losses occur?
  - Historical data for real-estate markets suggested gradual decline
  - Ratings, CDS, and active markets gave false sense of security
  - Exit became impossible with leverage and illiquidity

⇒ **Psychology of Greed Makes These Crises Unavoidable**

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Has This Happened Before?

Yes, Many Times (see Reinhart and Rogoff, 2008):

- 18 times since 1974
- 5 big bank-related crises:
  - 1977: Spain
  - 1987: Norway
  - 1991: Finland
  - 1991: Sweden
  - 1992: Japan
- Common themes:
  - Rising housing and stock markets
  - Capital inflows
  - Large public debt
  - Financial liberalization

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Crisis Preparation vs. Crisis Prevention

- Break up banks and broker/dealers that are “too big to fail”
- Create exchanges for CDSs and other large OTC contracts
- Create financial NTSB for analyzing all blow-ups
- Require confidential disclosure regarding “network” exposures
- Implement counter-cyclical leverage constraints for bank-like entities
- Enforce “suitability” requirements for mortgage-broker advice
- Require certification for mgmt. and boards of complex financial institutions
- Impose more mark-to-market accounting and risk controls
- Impose capital adequacy requirements for all bank-like entities
- Create new discipline of “risk accounting”
- Impose small derivatives tax to fund financial engineering programs
- Revise laws to allow “pre-packaged” bankruptcies for finance companies
- Change corporate governance structure (compensation, CRO role, etc.)
- Teach economics, finance, and risk management in high school

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Crisis Preparation vs. Crisis Prevention

	MIT School of Engineering			Sloan
Year	Bachelor's	Master's and MEng	PhD and ScD	Finance PhD
2007	578	710	337	4
2006	578	735	298	2
2005	593	798	286	1
2004	645	876	217	5
2003	679	817	210	7
2002	667	803	239	3
2001	660	860	248	1
2000	715	739	237	2
1999	684	811	208	4

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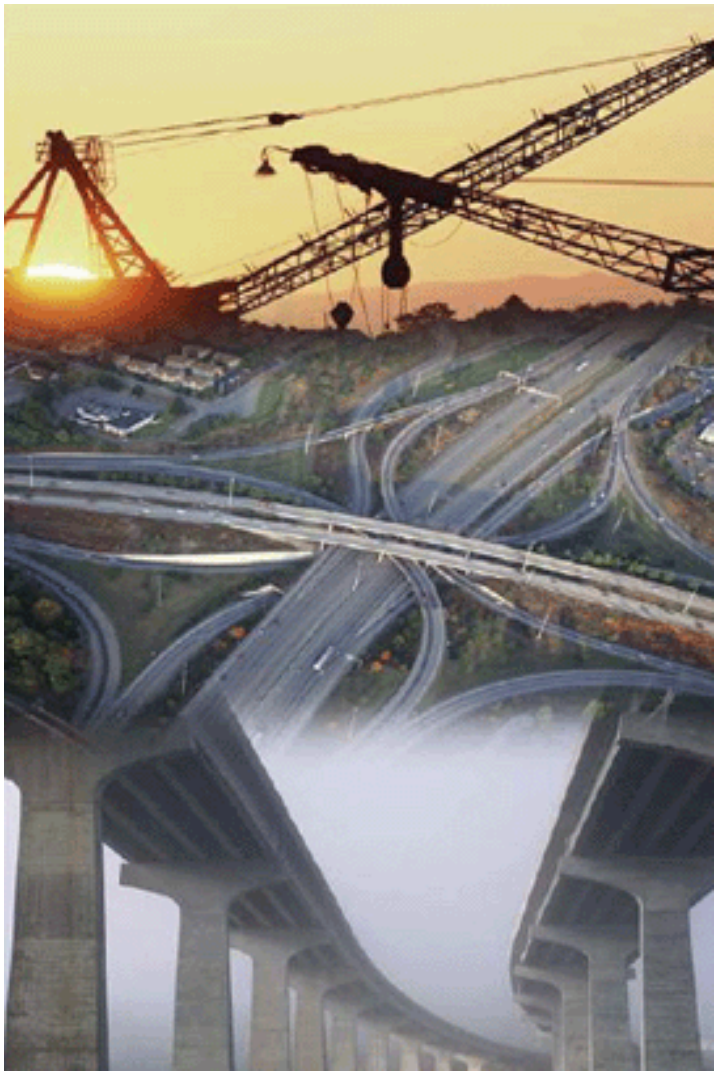
Conclusion

Over the Next Several Years, We Will Be Rebuilding Our Financial Infrastructure for the Next Century



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Thank You!

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