Lessons from the Financial Crisis: A Risk Modeling Perspective

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Outline

- My background
- My research related to the financial crisis
- Brief overview of the financial crisis
- Risk perspectives
- Market risk and the financial crisis
- Credit risk and the financial crisis
- Some lessons

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About Me

- Robert Richards Chaired Professor of Economics
- Director of Outreach and Associate Chair
- Adjunct Professor of Finance (Foster Business School), Adjunct Professor of Statistics, Adjunct Professor of Applied Mathematics
- UC Berkeley undergrad
  » Econ and Stat double major
- Yale Ph.D. with emphasis in Econometrics and Finance
- Co-Director of new MS Degree Program in Computational Finance and Risk Management
Teaching

• Undergraduate
  » Econ 422 (investment, capital and finance),
  » Econ 424/Amath 540 (computational finance)

• Graduate
  » Econ 582/583 Econometric Theory
  » Econ 589/Amath 546 Financial Econometrics and Quantitative Risk Management
Research Related to Financial Crisis

- Factor model based risk analysis
- Statistical modeling and risk analysis of hedge fund data
  » Joint work with Doug Martin (statistics) and PhD students in cooperation with the UW Endowment and BlackRock Alternative Advisors
Origins of the financial/economic crises

- Monetary policy easy 2003-05
- Underestimated risk in financial mkts
- Failures of corporate governance
- Households saving too little, borrowing too much
- Federal budget deficits

Stock market bubble
- Excessive leverage in financial institutions
- Stock market crash

Housing bubble
- Housing crash
- Lower long-term econ.growth
- Eventual loss of US global hegemony

Financial crisis 2007-08
- Predatory lending
- Excessive complexity
- MBSs
- CDOs
- CDSs

Recession 2008-09
- Oil price spike 2007-08
- China’s growth
- Gulf instability

Source: NY Times
Risk Perspectives

- Market Risk
- Credit Risk
- Operational Risk (time permitting)
- Systemic Risk (time permitting)
Marked Risk

- **Market risk** is the risk that the value of an asset/portfolio will decrease due to the change in value of the market risk factors: equity, rates, credit, commodity and currency.
- **Factor risk models** are often used to estimate an asset’s exposure to market risk factors.
- Market risk is typically measured using so-called *tail-risk measures* such as *value-at-risk* (VaR) and *expected tail loss* (ETL).
- VaR is used for setting regulatory capital (Basel I) in banks and is routinely used in risk reports of investment managers.
Tail Risk Measures

Area under curve beyond 5% VaR = 5%

ETL

VaR

± SD

Returns

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Tail Risk Measures During the Financial Crisis

- Tail risk measures require you to specify a **probability distribution** for asset returns
  - Asset returns for many assets are non-normal and subject to *Black Swan* events
  - The financial crisis was a Black Swan event!
- Market risk is directly related to **market volatility**. During the financial crisis market volatility increased dramatically
- Most tail risk measures grossly underestimated the losses attained during the crisis
Tail Risk Measures During the Financial Crisis

- Market risk for portfolios depends on the *correlations* between the assets in the portfolio
- In normal times diversification reduces risk
- During the financial crisis, diversification failed as *asset class correlations* dramatically increased
  » Tail risk concentrates as all assets move together

Web Link for rolling heat map

[http://cache.cantos.com/flash/hsba-r001/hsba-r001.avi](http://cache.cantos.com/flash/hsba-r001/hsba-r001.avi)
2. I. “Normal” (2005 to mid 2006)

Asset class correlation heat map

Source: HSBC, Bloomberg
7. VI. Crisis high point – strengthening correlations

Asset class correlation heat map

Sovereign Bonds
Equity
Commodities
Vol

Source: HSBC, Bloomberg
Credit Risk

- Credit risk is an investor's risk of loss arising from a borrower who does not make payments as promised (i.e., defaults). Credit risk is inherent in any credit related security (e.g., corporate bonds, mortgages, MBS, CDOs, CDSs, etc).

- Credit risk has two components:
  - probability of default
  - size of loss given default

- Credit risk models are used heavily by ratings agencies in the pricing of credit related securities, in particular structured finance products.
Credit Risk and the Financial Crisis

- During the financial crisis many credit risk models for mortgage related securities failed miserably
  » Securities rated investment grade experienced massive downgrades!
- Models relied on historical behavior of house prices which didn’t include the possibility of price decreases
- Models could not account for tail dependence in defaults (reliance on the Gaussian copula)
  » See Wired (2009), “Recipe for Disaster: The Formula that Killed Wall Street”
Example: CDO Ratings

- A typical collaterized debt obligation (CDO) is a collection of residential mortgages whose cash flows are separated into prioritized tranches of different credit risks (senior, mezzanine, junior)
- CDOs helped to facilitate the originate-to-distribute model of mortgage banking
- CDOs were rated on the same scale as bonds by one of the major rating agencies so that investors subject to ratings-based constraints would be able to purchase them
Example: CDO Ratings

- The tranching of mortgage cash flows allowed rating agencies to assign *AAA ratings to senior tranches* even if the average rating of the mortgages in the CDO were well below AAA (e.g. subprime)
- The *key factor* determining the ability to create tranches that are safer than the underlying collateral is the *extent to which defaults are correlated* across the underlying assets
- Rating agency models commonly assumed low and equal pair-wise default correlations
Why Everybody Loved CDOs

- **Investors**: They got a higher interest rate for a “comparable level of risk”
- **Rating Agencies**: For the years 2000-2006 they got 40% of their revenue from rating structured finance vehicles which includes CDOs
- **Mortgage Originators**: They could do more business without using up their balance sheet or taking credit risk.
- **Home Purchasers**: Many more people could buy homes —including some that should not have done so
- **The Government**: CDOs created placement for mortgage assets beyond Fannie Mae and Freddie Mac.

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Then the Party Ended

- At the peak in 2006 CDO issuance was $520 B
- Issuance in 2007, 2008 and 2009 was 481 B, 61 B and 4B, respectively.
- A large fraction of these CDOs used subprime mortgages as their underlying assets. When the housing bubble burst...
  - Subprime mortgages had higher defaults than assumed by the rating agency models
  - Subprime mortgages had higher default correlations as the result of pooling mortgages from similar geographic areas and vintages
  - AAA rated senior tranches behaved like *economic catastrophe bonds* – defaulting only during a crisis
Conclusion: Some Lessons

- Commonly used models for market and credit risk that work well in normal times often do not work well in times of crisis – *exactly when they are needed most!*
- Model parameters change during periods of crisis and failing to recognize this can lead to disastrous results
References


