

After the storm:
current perspectives in financial mathematics

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Is it over ?

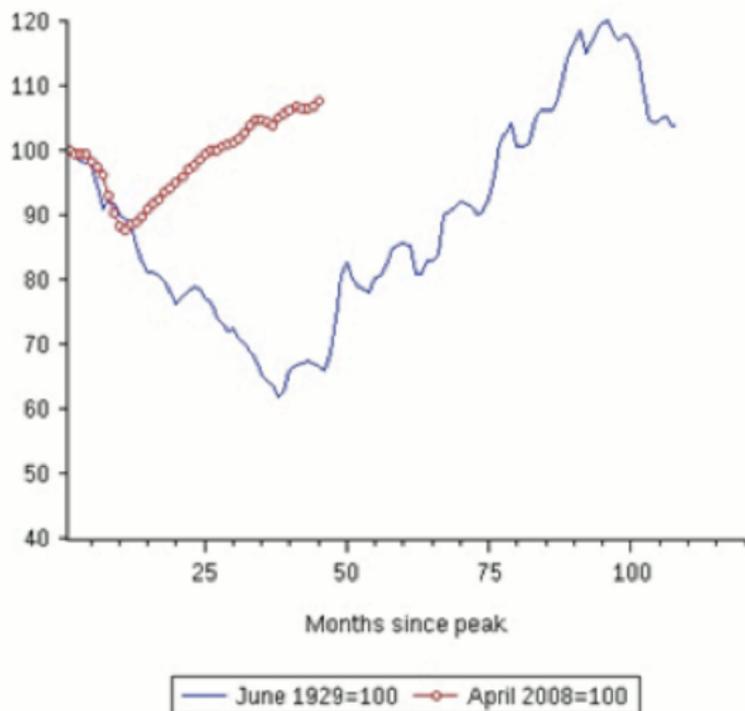


Figure: Eichengreen and O'Rourke 'A tale of two depressions', 2012

What about the stock market ?

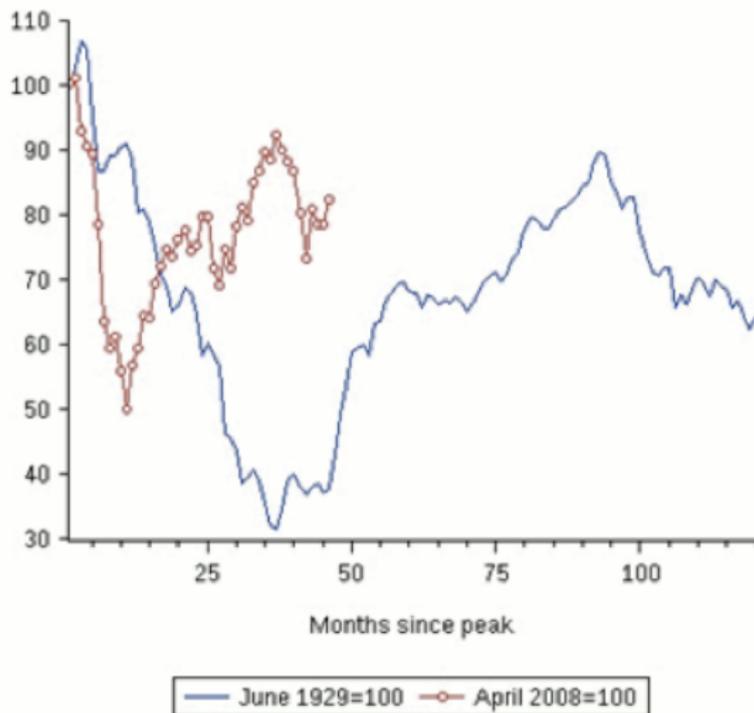


Figure: Eichengreen and O'Rourke 'A tale of two depressions', 2012

Meanwhile in Britain...

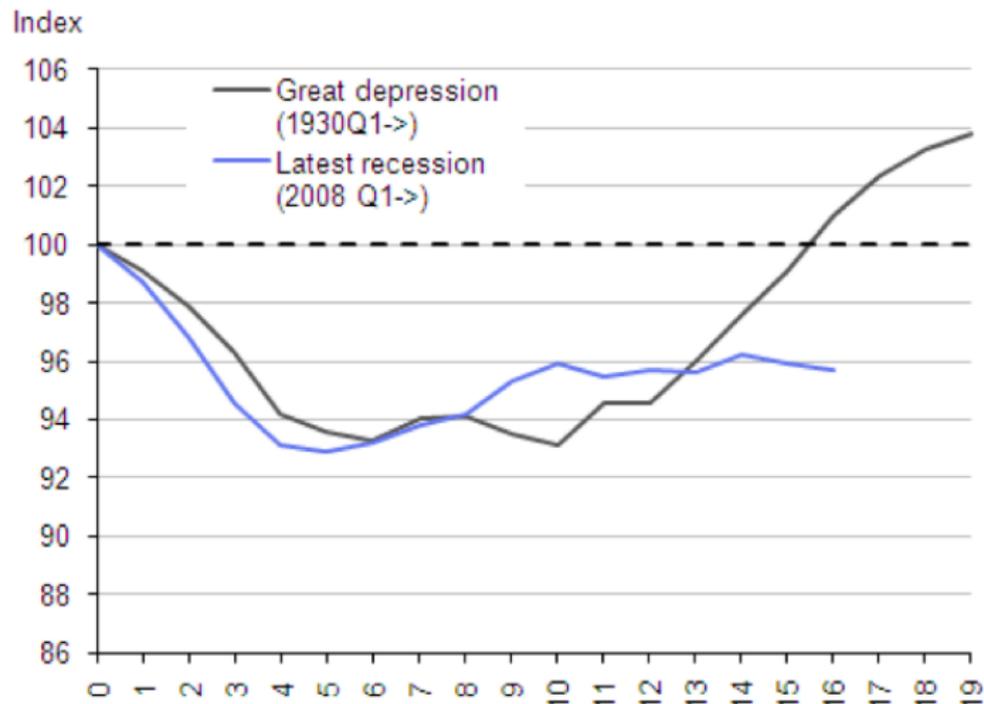


Figure: Office for National Statistics (UK), April 2012

A brief history of financial math: infancy

- ▶ Portfolio selection: Harry Markowitz (1952)
- ▶ CAPM: William Sharpe (1964)
- ▶ Brownian motion-driven models: Paul Samuelson (1965)
- ▶ Option pricing: Black–Scholes–Merton (1973)

A brief history of financial math: adolescence

- ▶ Risk-neutral pricing: Harrison–Pliska (1981)
- ▶ Utility maximization: Karatzas–Lehoczky–Shreve–Xu (1990)
- ▶ Modeling with jump processes: Madan–Seneta (1990)
- ▶ Interest rate modeling: Heath–Jarrow–Morton (1992)
- ▶ Stochastic volatility modeling: Heston (1993), Dupire (1994)
- ▶ FTAP: Delbaen–Schachermayer (1994)

A brief history of financial math: adulthood

- ▶ *Financial Mathematics* at Isaac Newton Institute (1995)
- ▶ Bachelier Finance Society (1996)
- ▶ Explosion of Master's programs
- ▶ Creation of research groups in mathematics departments
- ▶ Creation of dedicated journals
- ▶ *Developments in Quantitative Finance* at Isaac Newton Institute (2005)

Prediction is very hard, especially about the future...

From our 2005 LOI:

- ▶ “In the past decade, Mathematical Finance (MF) has outstripped its infancy...
- ▶ “In its current phase, MF has developed a vast range of applications, and has brought in many new mathematical, statistical and computational methods...
- ▶ “MF abounds with fresh new applications and new mathematics is constantly being introduced and developed. This trend will continue- over future decades we expect MF will impact many areas as yet undeveloped...”
- ▶ “...the general trend of securitization, of which collateralised debt obligations (CDO's) and general asset backed securities are particularly important examples, offers a new level of mathematical complexity guaranteed to keep MF vigorous, useful and fascinating well into its twilight years.”

Chronology of the Crisis

- ▶ Default of subprime mortgages causes freezing of interbank lending (August 2007)
- ▶ Rescue of Bear Stearns (March 2008)
- ▶ Bailout of Fannie and Freddie (July 2008)
- ▶ Failure of Lehman Brothers causes credit crunch and stock crash (September 2008)
- ▶ Bailout of AIG (September 2008)
- ▶ Crisis spreads to Europe and emerging countries (October 2008)
- ▶ Beginning of Second Great Depression !

Causes of the Crisis

- ▶ Monetary Excess (abnormally low interest rates)
- ▶ Capital flows (trade imbalance)
- ▶ Change in regulation (repeal of Glass-Steagal Act)
- ▶ Lax oversight (growth of shadow banking)
- ▶ Housing bubble
- ▶ **Financial Innovation**

Monetary policy

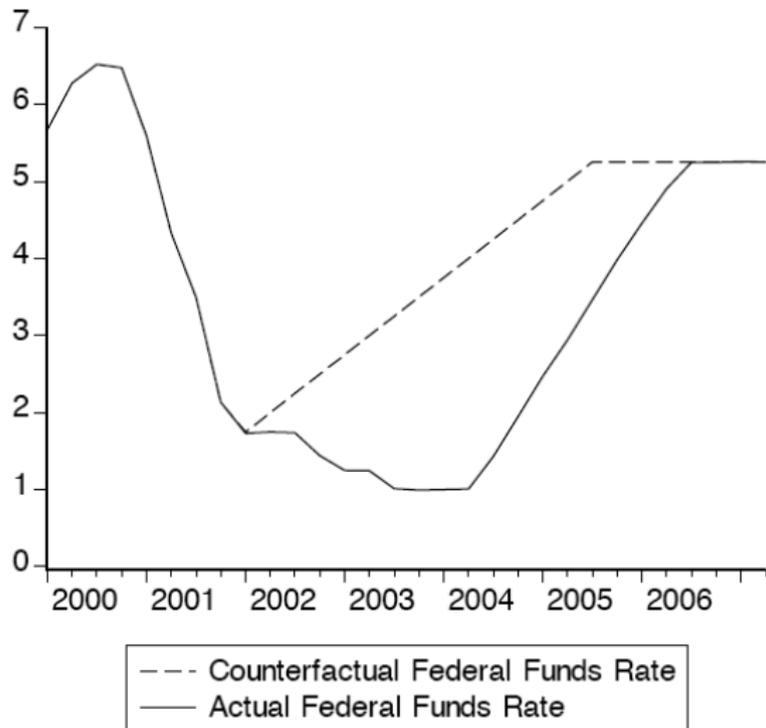


Figure: John Taylor, 2007

Capital Flows

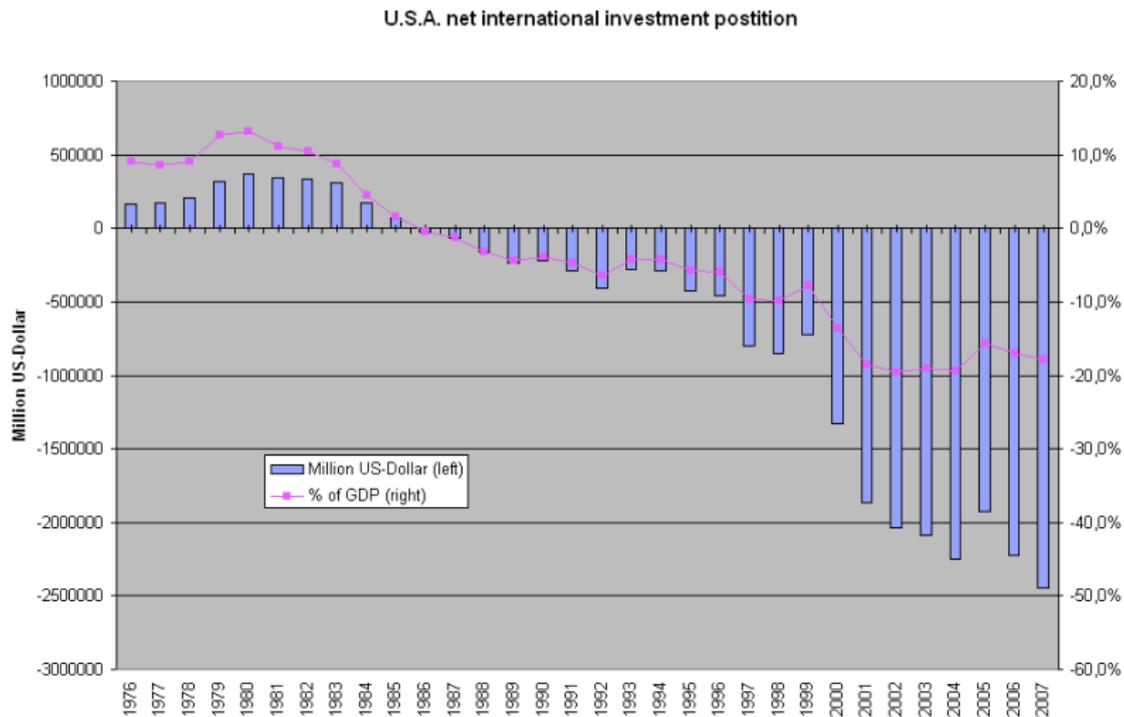


Figure: U.S. Bureau of Economic Analysis, July 2008

Shadow banking

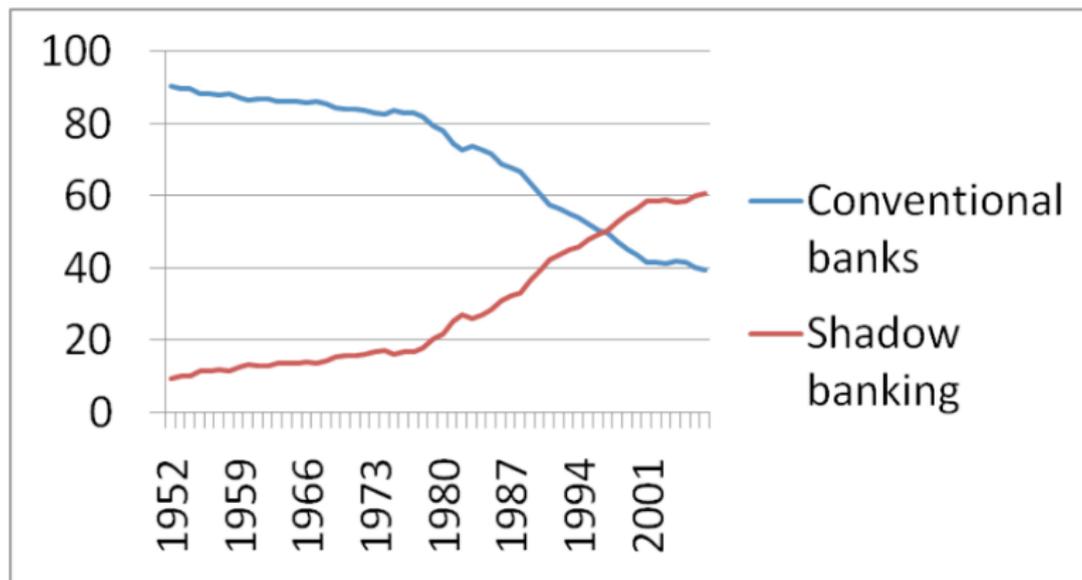
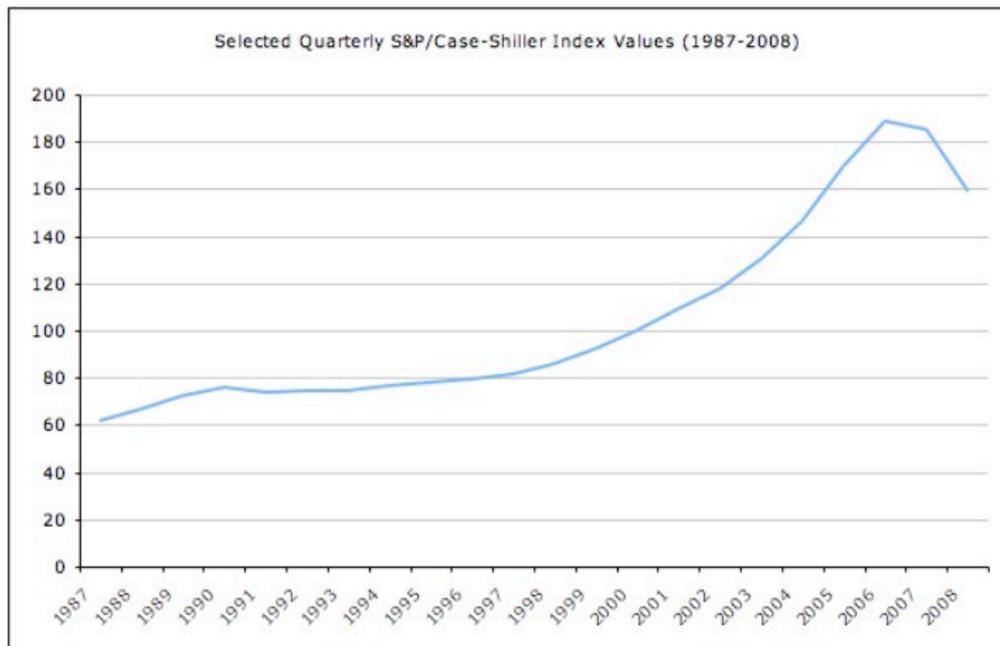


Figure: Paul Krugman, 2009

Housing Bubble



Financial Innovation

FINANCIAL-INDUSTRY PROFITS AS A SHARE OF U.S. BUSINESS PROFITS



PAY PER WORKER IN THE FINANCIAL SECTOR AS A PERCENTAGE OF AVERAGE U.S. COMPENSATION

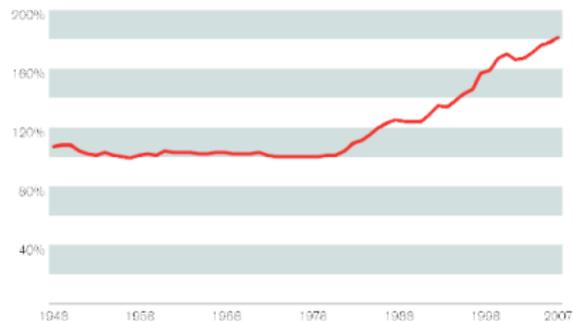


Figure: Johnson and Kwak , 2009

Theory of Crisis

- ▶ Mitchell (1913), Fisher (1933), Minsky (1977), Kindleberger (1978)
- ▶ Upswing driven by a displacement (new profitable opportunities to invest)
- ▶ Investment boom financed by bank money
- ▶ **Financial innovation** and leverage
- ▶ State of euphoria, bubble, over-indebtedness
- ▶ Dangerous timing game, bust
- ▶ Fire sale of assets, bankruptcies, bank failures
- ▶ Recession !

Modern twists

- ▶ Shifting risk from banks to shadow institutions increases the downside of a tail event.
- ▶ Over-reliance on superstructures (exchanges, rating agencies, mathematical models) makes the market less informationally diverse.
- ▶ Compensation for new intermediaries (fund managers, etc) is *convex* in returns, leading to riskier behavior.
- ▶ Relative performance evaluation induces herding, puts limits to arbitrage, leads to bubbles.
- ▶ Current risk management techniques (VaR) led to *pro-cyclicality* of leverage.
- ▶ The financial innovation at the core of the crisis (securitization) was overused without sufficient theoretical understanding.

THE
SECRET FORMULA
That Destroyed Wall Street

$$\mathbf{P} = \mathbf{\Phi}(\mathbf{A}, \mathbf{B}, \gamma)$$

Targeting quants

- ▶ Warren Buffet: derivatives are financial weapons of mass destruction, carrying dangers that, while now latent, are potentially lethal.
- ▶ Lord Turner (chairman of FSA): ...misplaced reliance on sophisticated maths to manage the risks
- ▶ Felix Salmon (Wired Magazine): 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.
- ▶ Paul Volcker: I will not accept the Nuremberg excuse.
- ▶ Nassim Taleb: we have to unmask the charlatans of risk like Myron Scholes. This guy should be in a retirement home doing Sudoku. His funds have blown up twice. He shouldn't be allowed in Washington to lecture anyone on risk.

Defending quants

- ▶ Steven Shreve: When a bridge collapses, no one demands the abolition of civil engineering. One first determines if faulty engineering or shoddy construction caused the collapse. If engineering is to blame, the solution is better—not less—engineering. Furthermore, it would be preposterous to replace the bridge with a slower, less efficient ferry rather than to rebuild the bridge and overcome the obstacle.
- ▶ Sir David Wallace (chair of CMS): Mathematics is surely the only medium capable of describing quantitatively the complex nature of the products that traders, risk managers, etc are handling, and the economic environment which they are operating in and influencing
- ▶ Carmona and Sircar: In fact, these geeks should have been listened to instead of being ignored or quarantined.

Let no crisis go to waste: new areas for financial math

- ▶ Limits of arbitrage
- ▶ Liquidity and leverage
- ▶ Accounting rules
- ▶ Incentive structures
- ▶ Improved risk management
- ▶ Systemic stability
- ▶ These topics represent a substantial broadening of the scope of mathematical finance
- ▶ By incorporating them, we expect mathematical finance to contribute more than just a technical tool for financial innovation.
- ▶ Hopefully society won't pass the following judgment on us:

IT'S A WONDERFUL LIFE (UPDATED)



THANK YOU !