Workshop on Writing and Communication in Research, 19-20 November, Sasana Kijang, Kuala Lumpur

Modelling Unknown Unknowns: Complexity vs Fragility

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19 November 2013

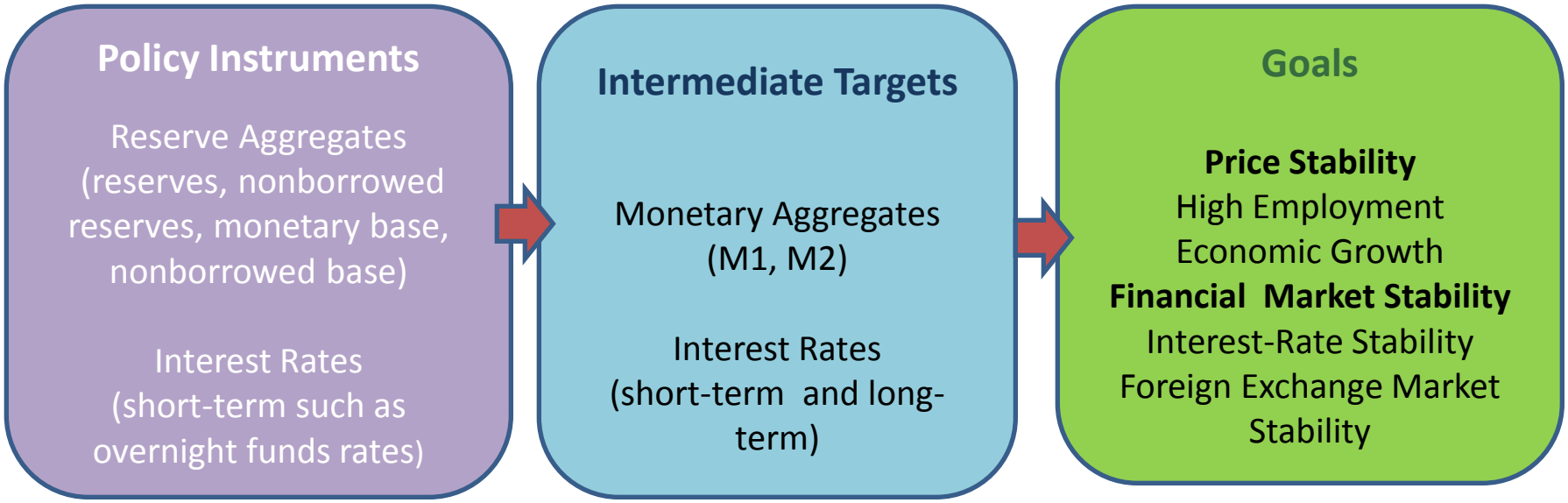
Overview

1. Introduction
2. Challenges to Economic Modelling
3. Quantitative Measures in Systemic Risk
4. Concluding Thoughts

I. Major Economic Questions

- What causes fluctuations in income, employment, prices, revenue and spending of government, imports and exports in economy?
- What determines economic growth, aggregate demand and aggregate supply in an economy in the short run?
- What kind of models can explain making of economic policy for higher rate of growth and for stability of an economy?

Basic Economic Policy Structure



Price Stability – Central Bank has the major responsibility to control inflation, growth rates of monetary aggregates and influencing the level and structure of interest rates.

Financial Stability – Central Banks has the new tasks of containing market risks or systemic risks which threaten to disrupt financial flows in the financial system, that serves as blood vessels to the economy at large.

The Price Stability Goal

- Low and stable inflation
- Inflationary problems
  - Creates uncertainty and difficulty in planning for future
  - Lowers economic growth
  - Strains social fabric
- Deflationary problems
- Time-inconsistency problem

The Taylor Rule, NAIRU, and the Phillips Curve

- Overnight interest rate = inflation rate + equilibrium overnight rate + ½ (inflation gap) + ½ (output gap)
- An inflation gap and an output gap
  - Stabilizing real output is an important concern
  - Output gap is an indicator of future inflation as shown by Phillips curve
- NAIRU
  - Rate of unemployment at which there is no tendency for inflation to change

The Phillips Curve

$$\pi_t = \alpha\left(u_t - u_N\right) + \pi_t^e \quad \text{where} \quad \alpha < 0$$

where π_t is the actual inflation,

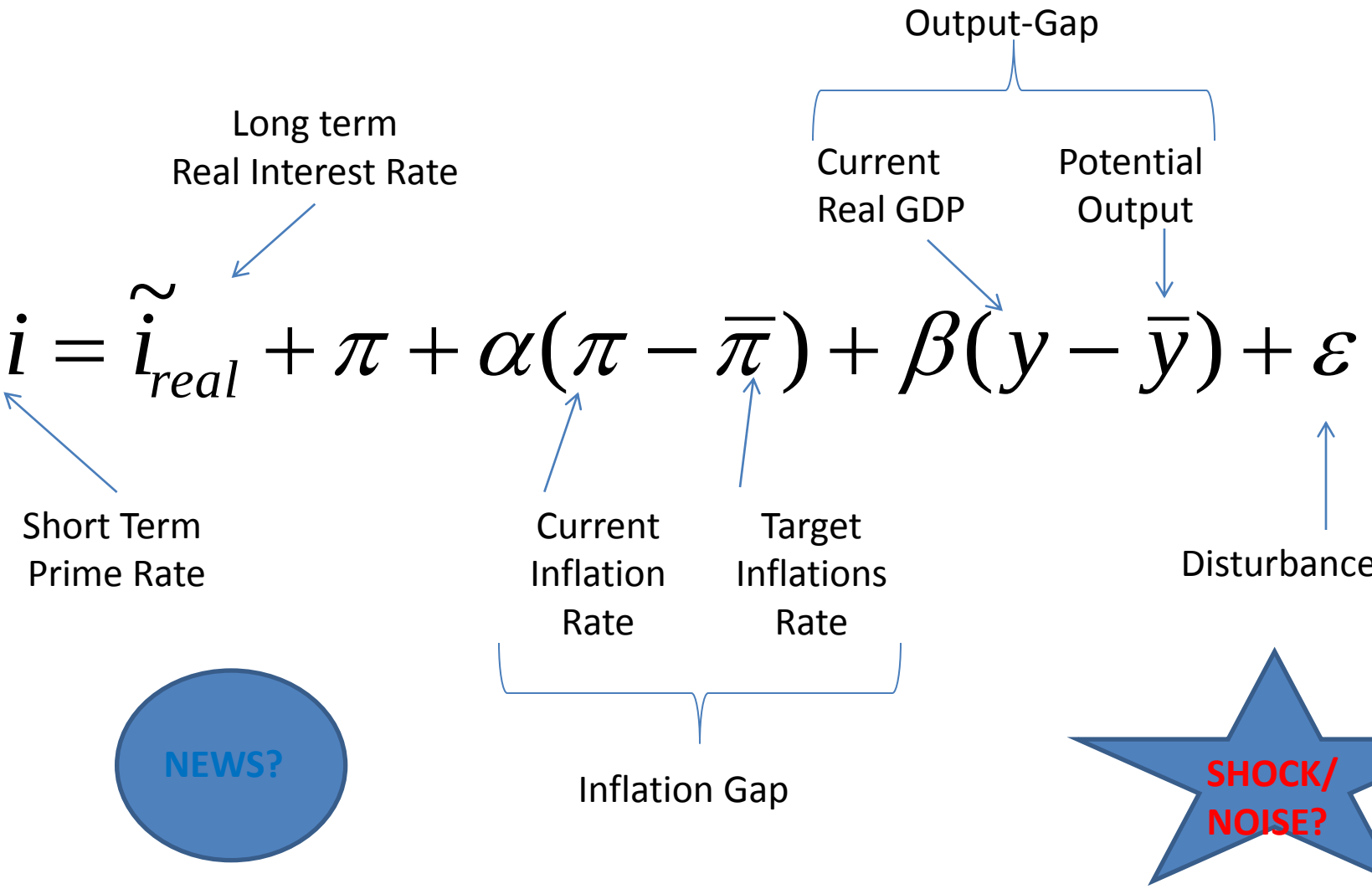
π_t^e is the expected inflation

u_N is the natural rate of unemployment that is ground out by the Walrasian system of the general equilibrium, and

u_t is the actual unemployment rate.

Friedman (1966, 1968) and Phelps (1967) natural rate of unemployment hypothesis

The Taylor-Rule



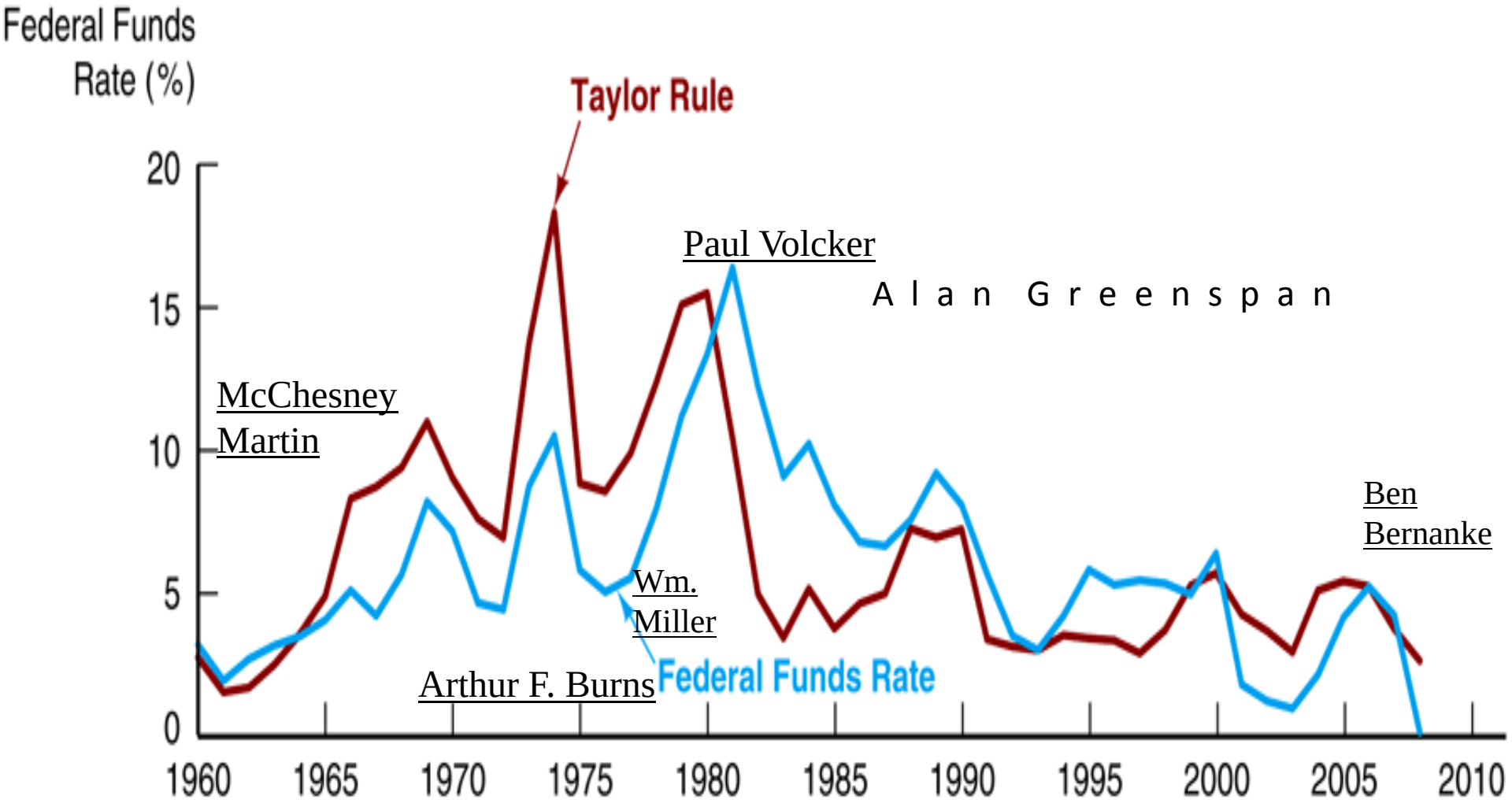
The Estimated Taylor-Rule

$$(i - \tilde{i}_{real})^{est} = a(\pi - \bar{\pi}) + b(y - \bar{y})$$

$$(i - \tilde{i}_{real})^{est} - a(\pi - \bar{\pi}) - b(y - \bar{y}) = \sigma$$

$$\sigma = \text{Estimated Model Error}$$

Taylor Rule for Federal Funds Rate:1970–2008



Source: Federal Reserve: www.federalreserve.gov/releases and author's calculations.

II. Challenges to Economic Modelling: "News" Versus "Noise"

- Do Data Provide "News" or Reduce "Noise"?
- **New Information** ⟶ **NEWS**
- **Measurement Error** ⟶ **NOISE**
- **News** – Correlated with revised data and uncorrelated with real-time data
- **Noise** – Correlated with real-time data and uncorrelated with revised data
- Mixed Results

New Challenges to Modelling (1)

- The GFC of 2008 has posed new challenges to economic modelling due to complexities and fragilities.
- GFC exposed the fundamental flaws of the shadow banking system (widely associated with financial innovations, financial engineering to achieve credit risk transfer and widely linked to the financial system and real economy).

New Challenges to Modelling (2)

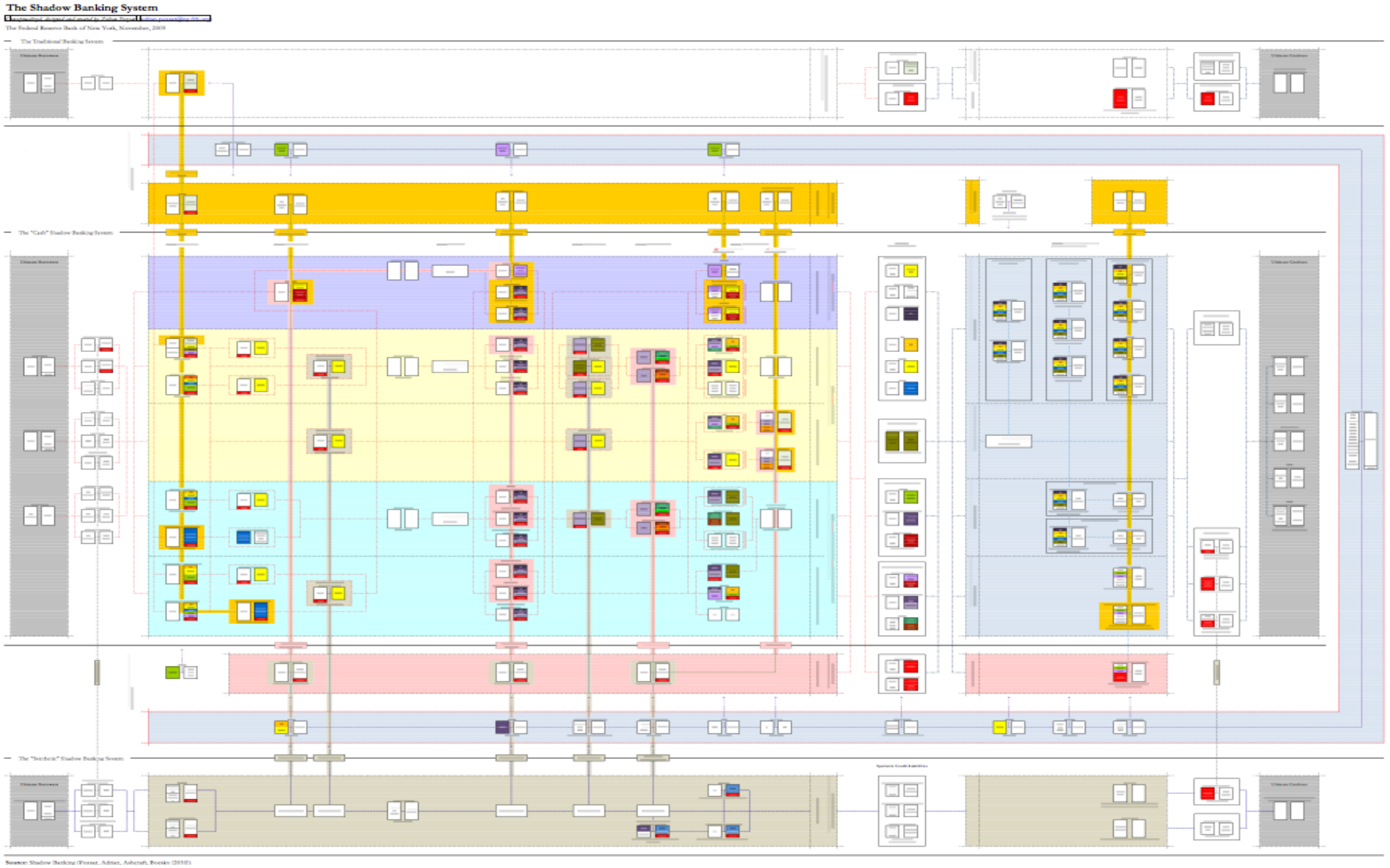
- Over reliance on David X. Li's Gaussian copula model misprices the risk of CDO's.

- In 2000, while working at JPMorgan Chase, Li published a paper in *The Journal of Fixed Income* titled "On Default Correlation: A Copula Function Approach." (In statistics, a copula is used to couple the behavior of two or more variables.) Using some relatively simple math—by Wall Street standards, anyway—Li came up with an ingenious way to model default correlation without even looking at historical default data. Instead, he used market data about the prices of instruments known as credit default swaps.
- Nassim Taleb proposes "antifragility" in systems, that is, an ability to benefit and grow from a certain class of random events, errors, and volatility as well as "convex tinkering" as a method of scientific discovery, by which he means option-like experimentation outperforms directed research.

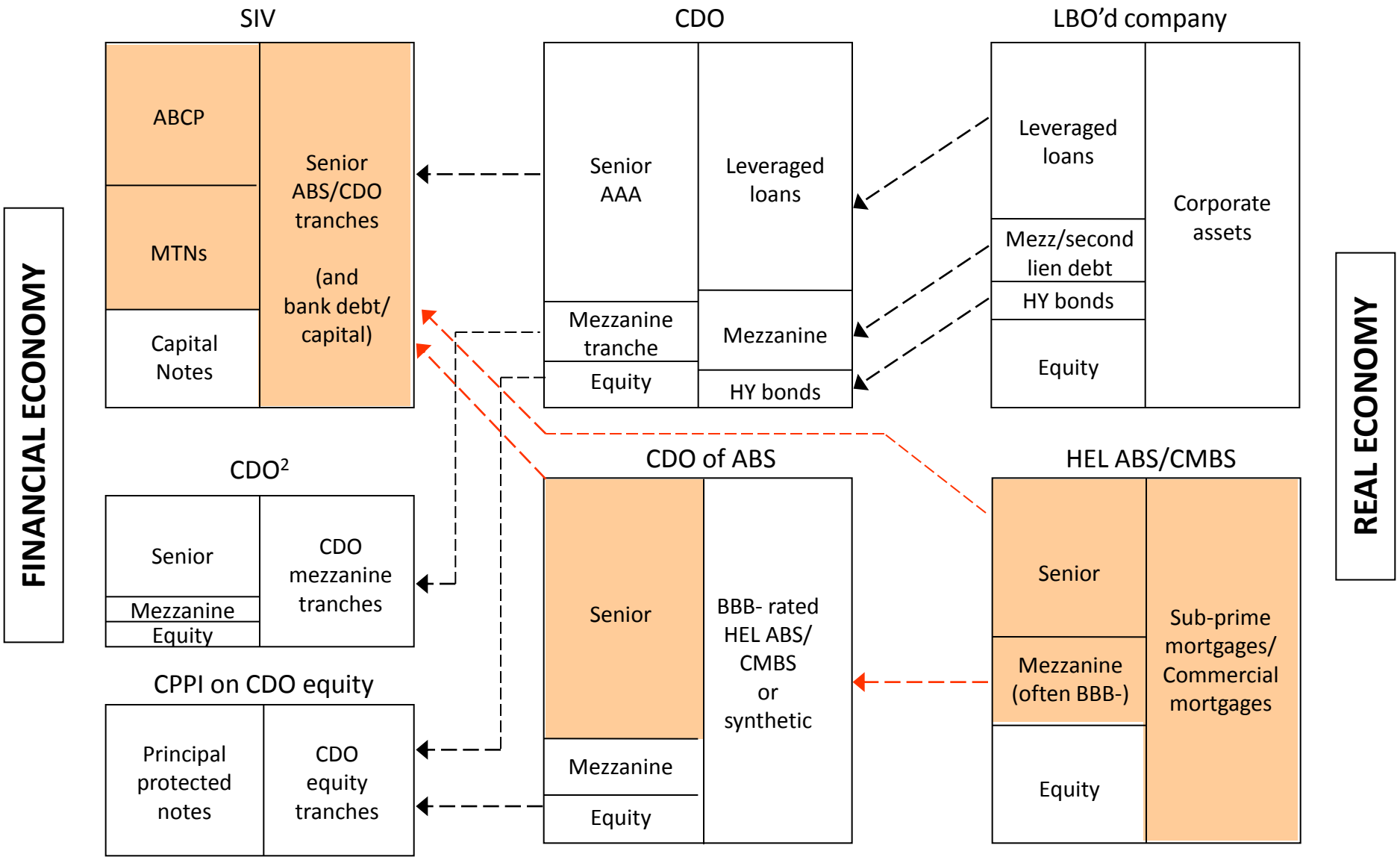
Fragility vs Complexity

- Fragility arose from the shadow banking system which masked the opacity of the financial products with fat tail risks.
- Shadow banks are inherently fragile.
- New financial innovations created more complicated financial products – in terms of measuring systemic risks.
- Complexity came in the form of network effects, off-balance sheet vehicles and counterparty risks.
- Complexity came in disguises of save financial products, eg. collateralized debt obligations (CDOs) and credit default swaps (CDSs).

US Shadow Banking Map – NY Fed 2010



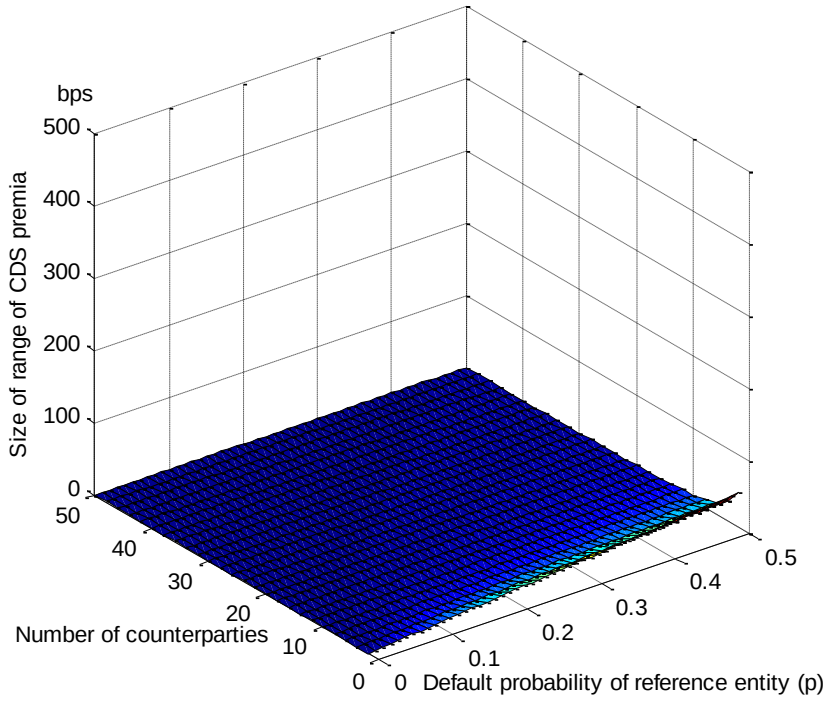
Financial Contract Design



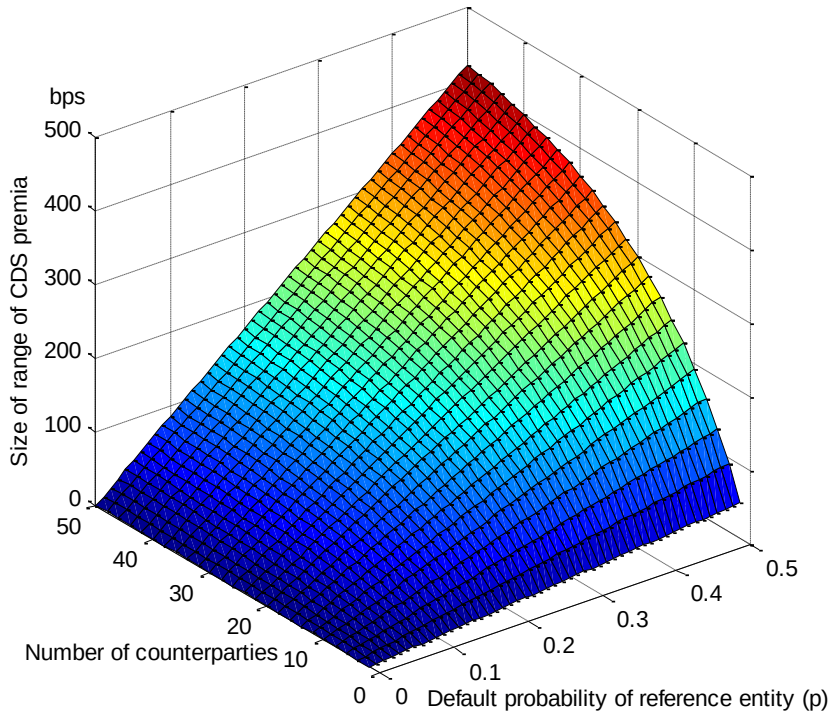
Source: Andrew Haldane (2009) "Rethinking the Financial Network"

Network Complexity: CDS Spreads and Crisis

CDS Premia and Network Uncertainty – Pre-crisis



CDS Premia and Network Uncertainty – Post-crisis



Source: Andrew Haldane (2009) "Rethinking the Financial Network"

Monetary Stability vs Financial Stability

- The big challenge to measure systemic risks is to identify when a financial network is potentially vulnerable and disruptions can trigger a collapse or tipping point.
- GFC showed that many micro and macro assumptions were wrong.

- Pre-GFC thinking: Once Central Bank gets price stability right, financial stability will follow suit.

  Monetary Stability → Price Stability = Financial Stability
- Post-GFC showed: Price stability and financial stability are two separate tasks.

  Monetary Stability→ Price Stability ≠ Financial Stability
- Most models have limiting assumptions stating market reversion to equilibrium.

Dealing with Unknown Unknowns

(Andrew Sheng, *Think Asian*, October 27 2012)

Failures of Theory

- Our micro and macro assumptions have turned out to be wrong.
- Many models have limiting assumptions that state that the market reverts to equilibrium.
- The theory is that negative feedback will propel the market back towards equilibrium.
- Market actually has positive feedback.

Failures of Models

- Finance models have limiting assumptions and two major flaws.
- The first is to state that behaviour can be modelled by a bell-shaped curve.
- The second is assuming that black swans are likely to be very rare, when in fact we've seen black swans can appear three or four times in one or two years.

Unfolding of Future of Finance
(Andrew Sheng, 2013)

- Crisis was formed **by excessive leverage** through nexus between banks and shadow banks
  - shadow credit not monitored and understood for their systemic (endogenous) instability within financial system

- Crisis was systemic crisis and can only be understood, not from neo-classical terms (back to perfection, equilibrium and self correcting) but from perpetual evolution of **Complex Adaptive Systems** (CAS) – of which national systems are parts and have large feedback mechanisms.

Source: Andrew Sheng (2013).*Outlook for Global Development Finance – Excess or Shortage,* United Nations High-Level Panel on the Post-2015 Development Agenda.

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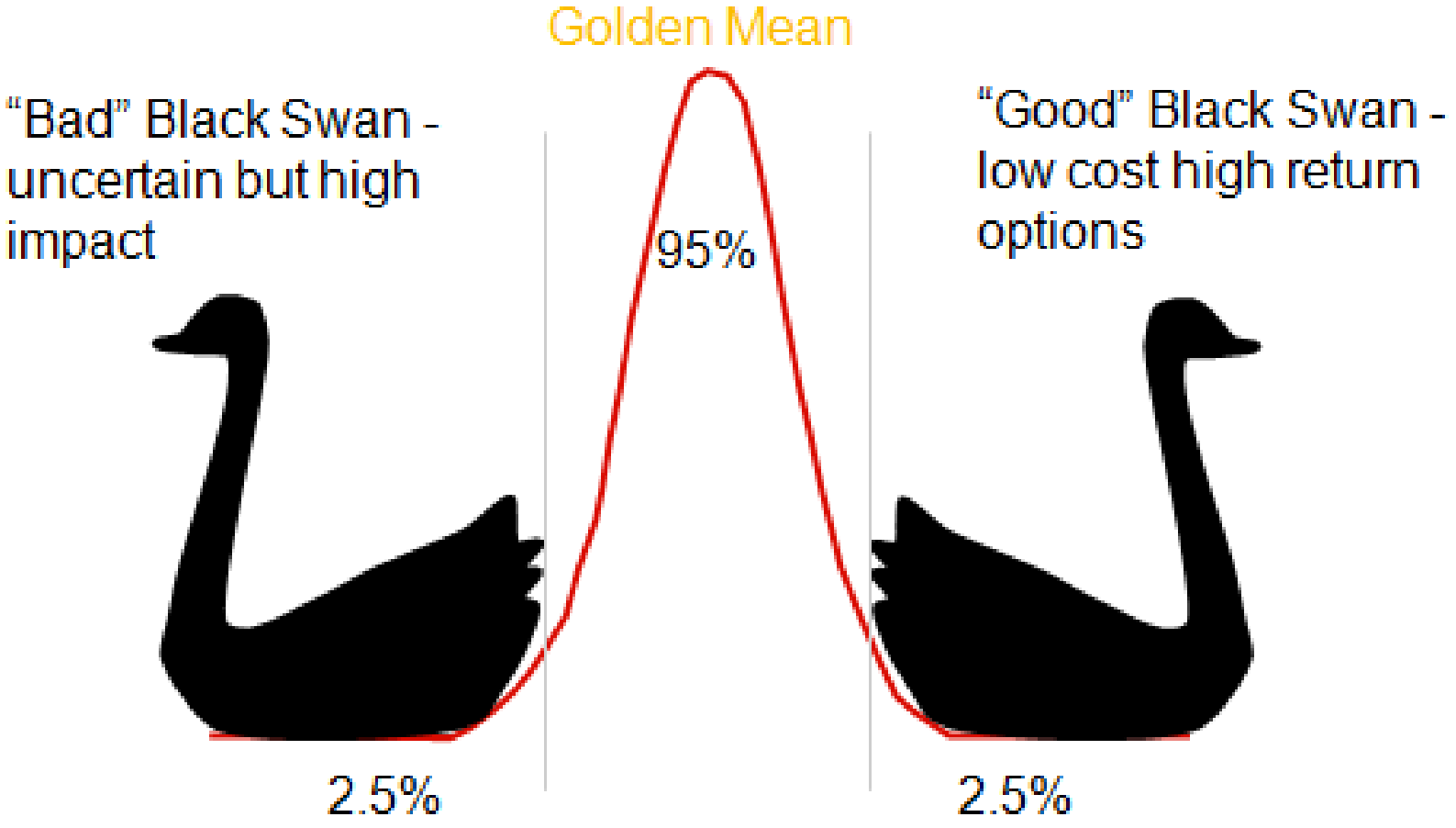
III. Quantitative Measures in Systemic Risk

- Tail Measures

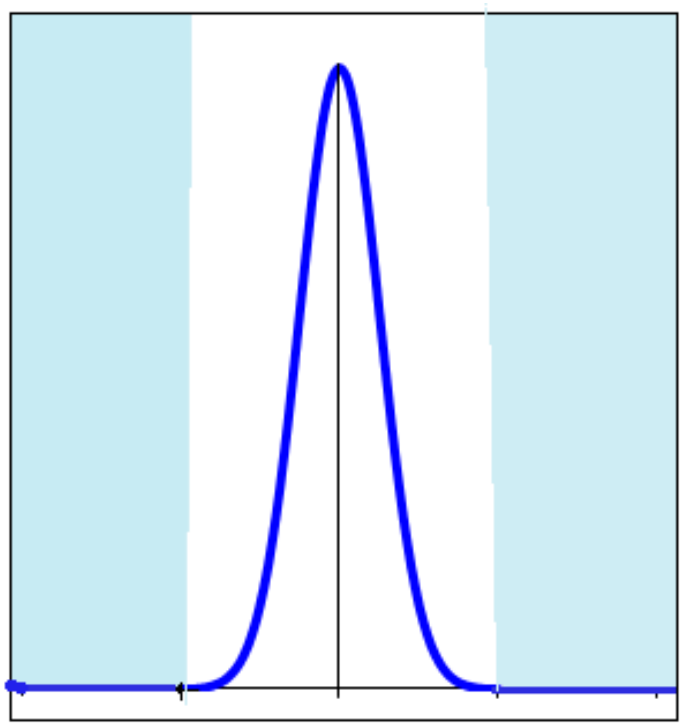
  The Black Swan: Second Edition: The Impact of the Highly Improbable: With a new section: "On Robustness and Fragility“ by Nassim Taleb (2007).

- Contingent Claims Analysis
- Network Models
- Dynamic Stochastic Macroeconomic Models

Dealing with Uncertainty (Black Swans) require Antifragile Actions – Nassim Taleb (2012)



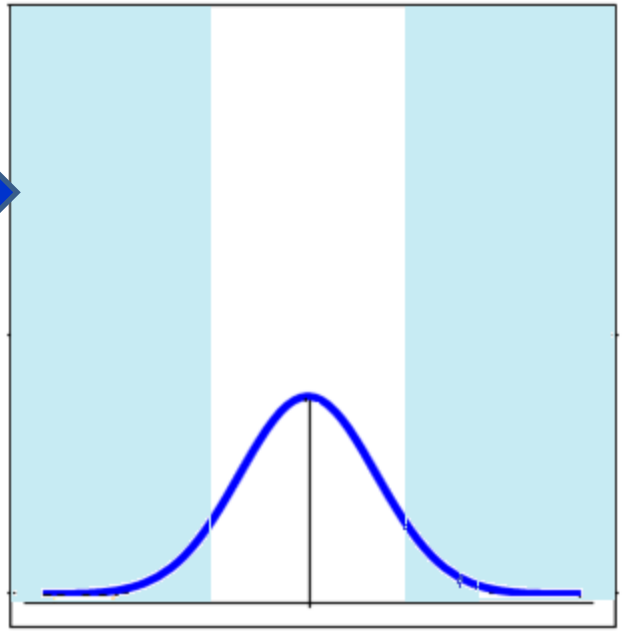
The Robust



- Left tail of the distribution and Right tail of the distribution are **thin.**
- Small negative and small positive outcomes.

The Fragile I

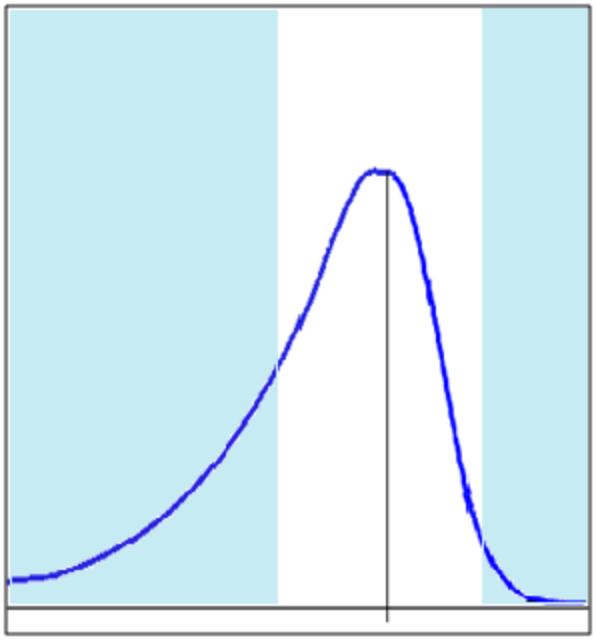
RARE



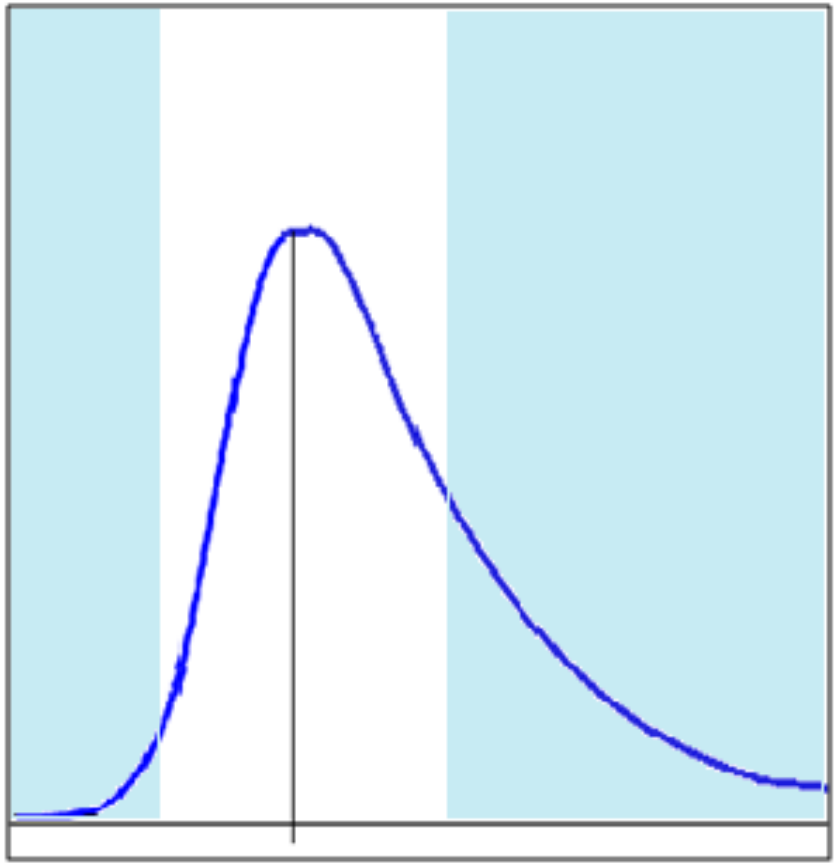
- Left tail of the distribution and Right tail of the distribution are **thick.**
- Large negative and large positive outcomes
- Symmetry is very, very rare empirically - yet all statistical distributions are bell shape.

The Fragile II

GFC



- Left tail of the distribution is **thick** and Right tail of the distribution is **thin.**
- Large negative and small positive outcomes.
- There is a possibility of a severe unfavourable outcome much more than a hugely favourable one.



The Antifragile

- Left tail of the distribution is **thin** and Right tail of the distribution is **thick.**
- Small negative and large positive outcomes.
- Large favourable outcomes are possible, large unfavourable ones less so (if not impossible).
- Right tail for favourable outcomes is larger than the left one.

IV. Main Problem in Economic Modelling

- Observability and measurability
- Controllability
- Unpredictable effect on goals

Launching the OFR Working Paper Series with A Survey of Systemic Risk Analytics

By: Jonathan Sokobin
1/11/2012

Page Content
The Dodd-Frank Act created **the Office of Financial Research** (OFR) because policymakers and the public need better data and analysis to help them assess and respond to threats to financial stability. With that goal in mind, the OFR is launching a Working Paper Series that will make available the OFR's work on the analytics and measurement of such threats in depth. Today, we release our first Working Paper -- *A Survey of Systemic Risk Analytics*, by Dimitrios Bisias (MIT), Mark Flood (OFR), Andrew W. Lo (MIT), and Stavros Valavanis (MIT). These papers, which will involve collaboration with OFR staff and experts nationwide, are works in progress published in order to elicit discussion among researchers and other interested parties. We hope these papers will spark a lively discussion to help refine our thinking. Based on that feedback, we will revise and update our research to constantly reflect the input and analysis of all stakeholders.
The first paper is focused on quantitative tools to assess threats to financial stability, which makes it an ideal piece with which to launch the OFR Working Paper Series. This survey provides a broad overview of the state of the art in measuring systemic risk by focusing on a key set of **31 specific measurements** outlined elsewhere in peer-reviewed articles or working papers. While this is only a small subset of the hundreds of papers that have been written about threats to financial stability, the 31 methodologies cover a wide variety of approaches available in the literature.

http://www.treasury.gov/connect/blog/Pages/Launching-the-OFR-Working-Paper-Series-with-A-Survey-of-Systemic-Risk-Analytics.aspx

Thank You