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Quantitative Finance in the post-Lehman Dodd-Frank Landscape

Stephen Blyth

Managing Director, Harvard Management Company
Lecturer, Department of Statistics, Harvard University

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Overview: Reshaping Forces

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- Fundamental logically-sound arguments were challenged and shown wanting, especially in immediacy of Lehman bankruptcy
  - Evaporation of liquidity and reduction of risk-appetite clearly a major driver
  - A new landscape: mathematics without the axiom of choice?
- Financial crisis brought widespread government intervention in markets from 2007 onwards - still evolving.
- Extensive regulatory reform and Dodd-Frank followed

How have quantitative finance and risk management evolved in landscape reshaped by these elements?
What are challenges for quants, investors and risk managers?

Introduction

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"*There is of course a possibility that the government will renege on its promise to pay (ie default). But if we pick the right government this possibility is sufficiently remote that we can for practical purposes neglect it. If this seems unreasonable, consider that if the British, American or German government reached such straits, the world's financial system would be in such a mess that there would be precious few banks left to employ financial mathematicians*."

– Mark Joshi, The Concepts and Practice of Mathematical Finance, Cambridge University Press (2003), **page 1**.

Decision-making with Limited Data and Experience

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- Derivative markets have limited history: eg first currency swap 1981 (World Bank/IBM); reliable data since 1990s+
- Majority of market participants less than 15 years experience ("SSC generation")
- Data and experience to inform judgment are limited – thus decisions made conditional on small-scale frame of reference.
- Revealed "universal set" of events proved very different.

Reshaping Force:

Empirical Challenges to Fundamental Arguments

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- Conundrum of uncollateralized vs collateralized funding rates
- Off-balance sheet arbitrage
- Violation of triangle inequality

Example I

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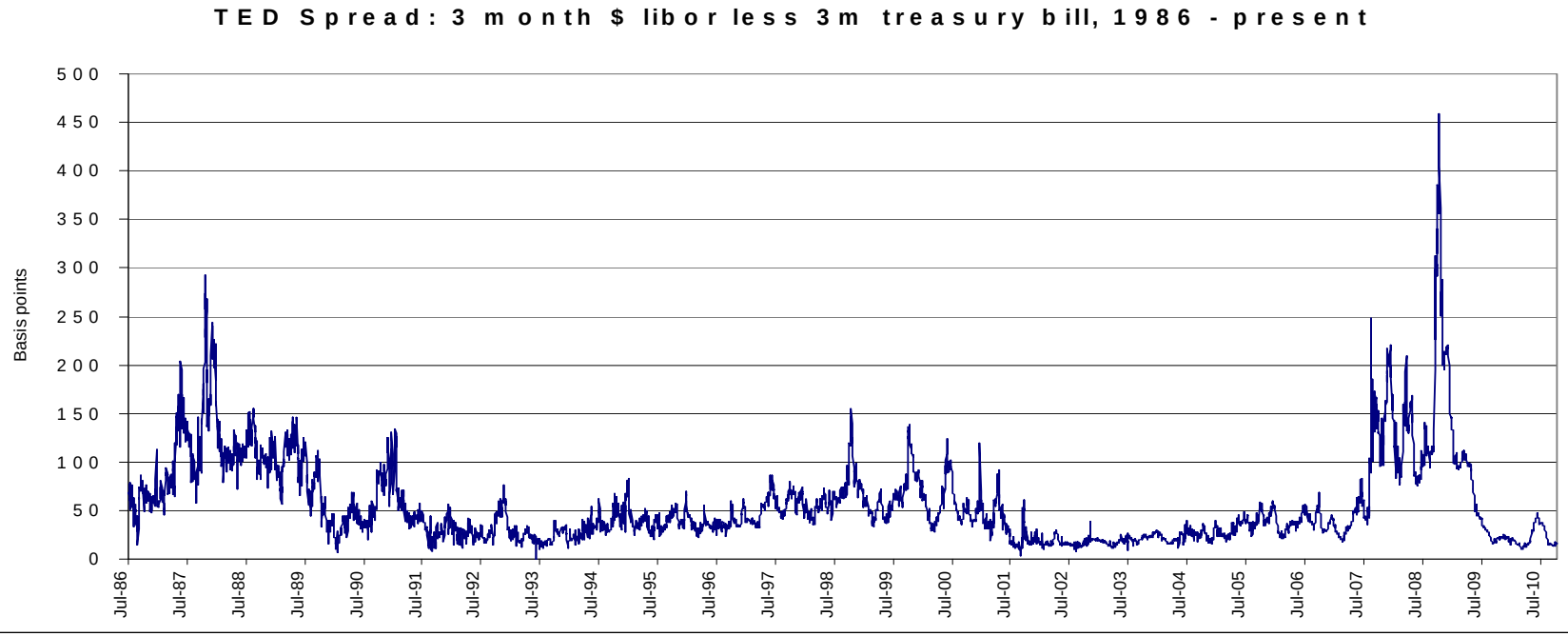
- Argument: collateralized funding, in particular that secured by government debt, should be cheaper than uncollateralized funding.
- History: at times of stress, TED spread increases as investors seek safety of government bills; has always been positive



Example I cont'd: Swap Spread on Repo

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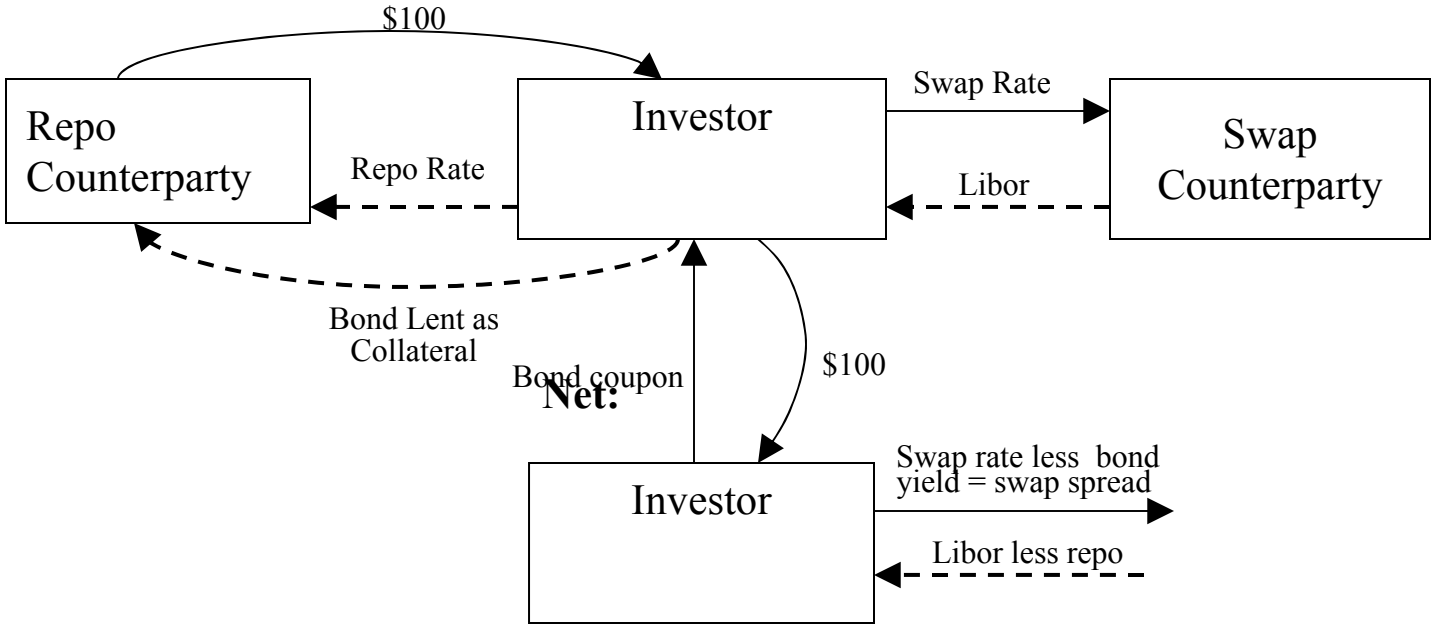

Example I cont'd: Swap Spreads

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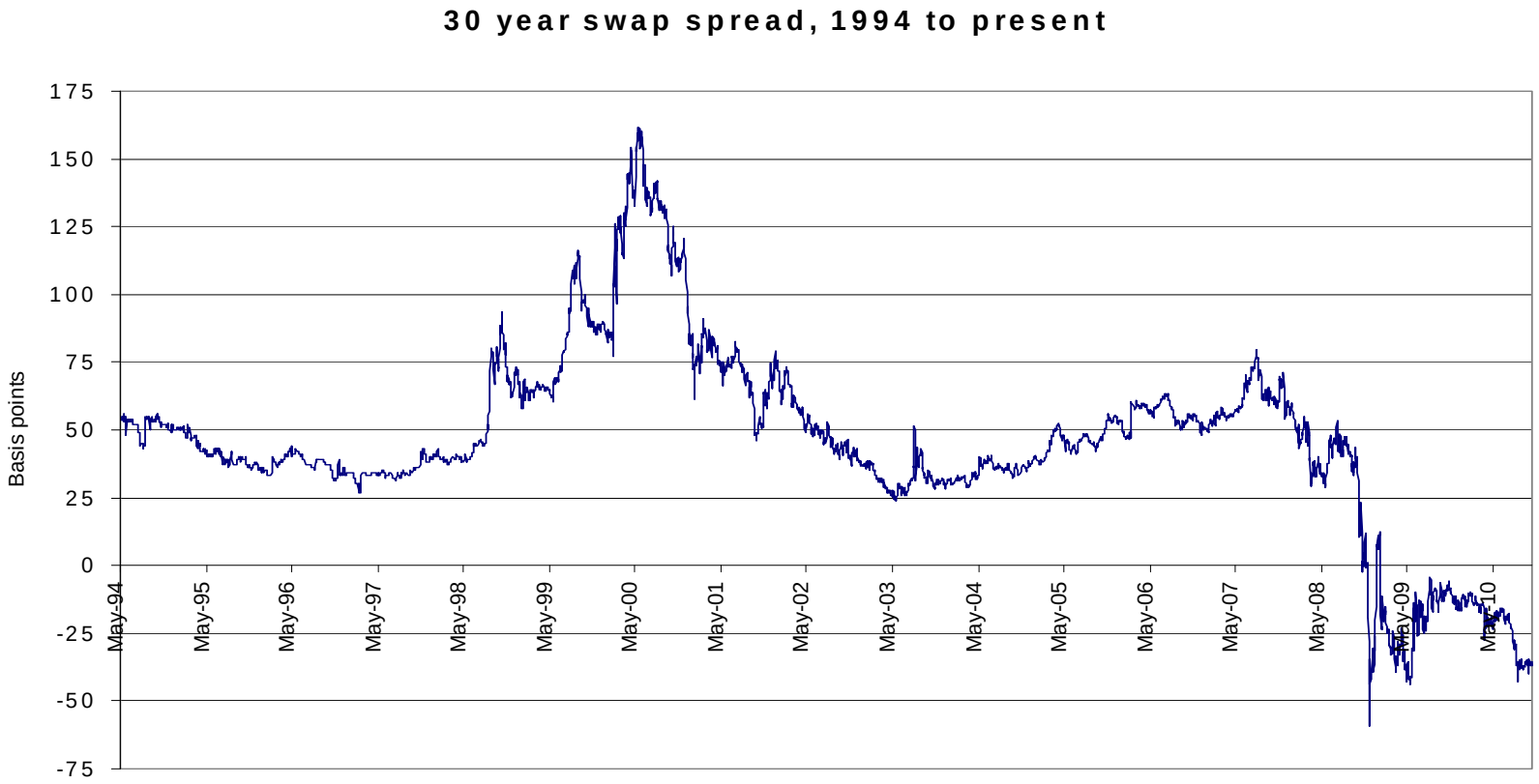

Example II: Off-balance sheet arbitrage

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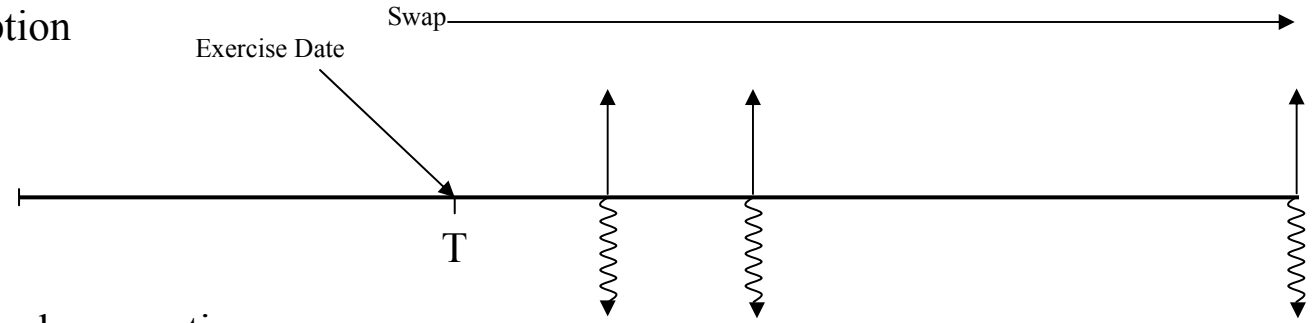
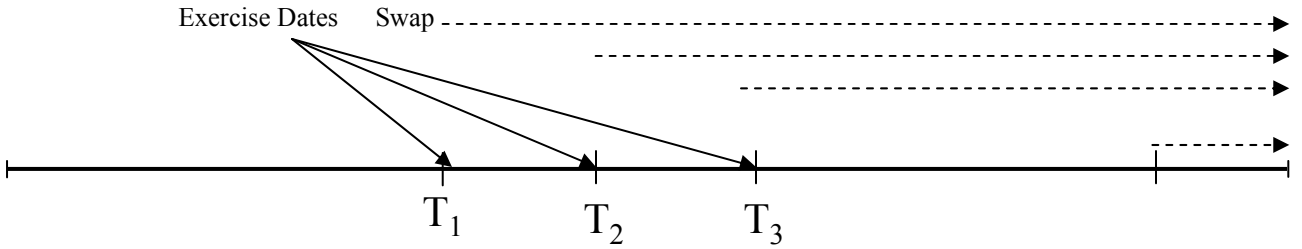
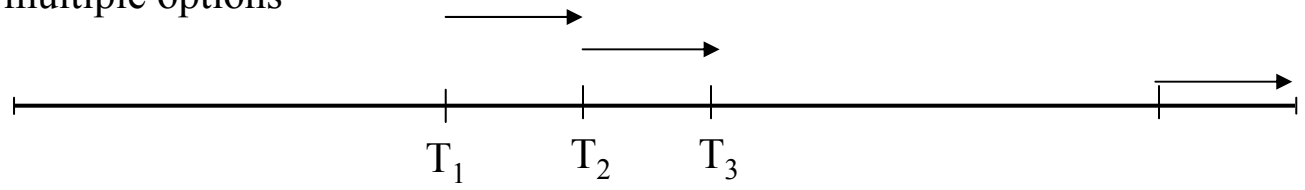
A swaption



A Bermudan swaption



A floor - multiple options



Example III:

Violation of the Triangle Inequality

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X: value of K_1 strike call on A

Y: value of K_2 strike call on B-A

Z: value of K_1+K_2 strike call on B

Triangle Inequality: $X+Y \geq Z$

The New Landscape – a Mathematical Analogy

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- Assumption of Axiom of Choice (≡ Zorn's Lemma) allows well-ordering of real numbers
  - Without axiom, set theory is doable - but messy. Orderings become complex
- Assumption of elementary arbitrage bounds (Bermudan ≥European) allows relative-value derivative pricing
  - Without such bounds, derivative pricing and risk management becomes more complex – but products still exist
- Analogy extends: Axiom of Choice implies existence of counterintuitive objects! Eg. Banach-Tarski paradox. Post-Lehman experience represents financial equivalent.

Reshaping Force: Government Intervention

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- Initially alleviated several problems
  - liquidity returned to several sectors and market functionality returned
  - corporates and in particular banks able to fund themselves (TLGP)
  - counterparty risk improved, panic levels about systemic risks declined
  - risk-taking returned as investors observed government capital do sensible trades (QEI)
- But raised other issues for investors and risk managers
  - certain markets dominated by government, hard to trade
  - entered uncharted economic and policy waters
  - Plus: the spectre of significant regulatory overhaul loomed

Government Intervention –the Umbrella?

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- Government driven market segmentation:
  - QE normalizes and provides deep liquidity to UST market (just right?); yet markets outside umbrella remain prone to liquidity evaporation
  - Asset purchases normalized a stressed mortgage market, yet subsequently stressed a normalized market (too hot?)
  - Dodd-Frank regulation injects significant uncertainty into future of derivatives market and risk-taking (too cold?)
- This may not be Goldilocks

Reshaping Force: Market Regulation

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- Uncertainty remains about risk-taking incentives and ability at major financial institutions (Volcker, Section 716, reporting etc)
- For first time, universe of traded derivative risks shrinking. Viability of derivative strategies – on buy and sell-side – questioned.
- Extent of shrinkage and subsequent investor response unclear. Ability to trade risk parameters at will no longer exists.

Navigating the New Landscape

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- Challenges and Opportunities

  - What are new equilibria/arbitrage bounds for derivative prices in post-Lehman Dodd-Frank world - without Axiom of Choice?
  - Where will future government economic action impact markets? Can one model government as rational investor? How does one trade QEII vs QEI?
  - How will rule-making play out? How will it reshape derivative markets, opportunities and risk-taking?

  - How does one assess probabilities, make investment decisions, manage risk, within larger conditioning set?
  - Alpha dividend or alpha deprivation for investors?

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