Observations on Financial Innovation and Finance Science

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Overview of my remarks

• Well-functioning financial system is essential for sustainable economic growth and development (Solow; North).
• Financial innovation drives improvement of the financial system
• Finance science, technology, and economic need drives financial innovation
• Crisis breeds implementation of innovation which leads to an improved financial system: observations from the 1970s
• Financial innovation can solve real-sector challenges: case of Leipzig gas pipeline in 1990s
• Directions of innovation in the future
• New tools for improving financial stability of capital markets
• Interaction between monetary, fiscal and financial stability policies: potential for unintended consequences
Financial and Economic Crisis 1970s: Risk Explosion and Stagflation

- Multi-dimensional explosion of volatilities in the western economies reflected in financial systems
- Fall of Bretton Woods currency system
- First oil crisis in 1973-4 and a second one in 1979
- Double-digit inflation in the US highest since Civil War
- High unemployment ~9%:
  - “Stagflation” unknown, and still unsolved, economic disease
- Stock market fell 50% in real terms mid 1973 – 1974
- Double-digit interest rates, highest since Civil War
- No mortgage money available: Regulation Q
- 1973-1975 recession was really a 1970s recession because its effects extended into the 1980s
Risk Explosion and Crisis 1970s Drives an Explosion of Extraordinary Financial Innovation

- Option exchange: financial value insurance
- Financial futures for currencies, interest rates, stocks
- NASDAQ, first electronic stock market
- Money market funds, high-yield and floating rate bonds
- Mortgage securitization and a national mortgage market
- Index funds Stage Coach Fund 1970 & Vanguard 1975
- TIAA-CREF international diversification in stocks 1972
- May Day 1975 negotiated commissions & Vanguard created
- ERISA 1974 modern employer-funded pension system
- Interest rate swap –eliminates the largest bank risk
- Eliminate destructive regulations: deposit rate ceilings
- Finance science applied: portfolio theory; asset pricing models; Black-Scholes option model; large-scale stock price data bases
Using Contracts as Substitutes for Physical Assets for Greater Efficiency and a Greener World: Leipzig Gas Pipeline 1990s

German reunification created rapid economic development and an increased power demand. To meet this demand, a natural gas power station in Leipzig had two options:

**Option 1**

Spend $50M for a pipeline to the European gas grid and buy UK, Norwegian and Dutch gas at spot prices indexed off the USD price of heating oil at the Upper Rhine delivery point.

**Option 2**

Spend $300M for a new pipeline to connect to the Russian gas grid and enter a 15 year fixed price contract in Deutsche Marks.

From Peter Hancock, AIG, 2014
### Contractual Synthesis of Assets: Leipzig Gas Pipeline (cont.)

<table>
<thead>
<tr>
<th></th>
<th>Option 1</th>
<th>Option 2</th>
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<tbody>
<tr>
<td>Capital Investment</td>
<td>$50M</td>
<td>$300M</td>
</tr>
<tr>
<td>Advantages</td>
<td>Reduced political risk by avoiding dependence on Russians Lower capital investment</td>
<td>Stable prices of power potentially useful to population accustomed to price controls</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>Gas price volatility</td>
<td>High capital investment</td>
</tr>
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Option 1 was more attractive with hedging, but had two significant problems:

1. **Limited hedge instruments available:**
   2. Crude oil call up to 5 years in USD
   3. Crude/heating oil basis swaps up to 2 years
   4. FX Options up to 5 years
   5. Currency swaps up to 10 years

2. **Limited sophistication of the city administration**

### Solution

A bank provided a 15 year cap on European gas prices at a strike price equal to the Russian fixed price contract in exchange for a premium of $125 MM. The cap is effectively a “synthetic pipeline”.

The price is half of the incremental cost of a physical pipeline to Russia and compensates the bank for hedge mismatches and the need to dynamically adjust hedges over 15 years.

Source: Peter Hancock, AIG, 2014
Financial Innovation to Address Global Challenge to Funding Retirement

Sources of potential non-sustainability of current retirement funding systems

- Shifting demographics: US, Europe, Asia populations aging rapidly
- Increasing longevity: population living longer
- Economy shift from rural agriculture toward city industrial
- Legacy of large unfunded liabilities of define-benefit and pay-as-you-go pension plans from inadequate contributions and overly optimistic return-earning
- Contribution and balance sheet risks too great for plan sponsors

Only four ways to improve the chances for achieving a good retirement

- Save more for retirement and lower lifetime consumption level
- Work longer before retiring
- Take more risk and be prepared for the consequences if the risk is realized
- Improve the income benefits from the assets that are already available
  - Annuities, including “tail-insurance” for longevity
  - Reverse mortgage – “home pension”
  - Goal-based investment strategies
  - Redesign employer contribution schedule, for fixed contribution cost
New Tools for Financial Stability

- Using market prices to assess the impact of monetary and other government policy announcements on beliefs about the future: Forward-looking versus historical-based probability assessments
- Measuring the degree of connectedness of financial institutions and sovereigns with respect to credit risk to identify vulnerabilities to systemic risk
- Generating stress test specifications endogenously
- Taking account of the interactions of monetary, fiscal and financial stability policies and unintended consequences of those policies
Risk Measurement for Credit-Risk Assets

Non-linear risks of being a lender when there is risk of default

\[
\text{RISKY DEBT} + \text{GUARANTEE OF DEBT} = \text{RISK-FREE DEBT}
\]

\[
\text{RISKY DEBT} = \text{RISK-FREE DEBT} - \text{GUARANTEE OF DEBT}
\]

<table>
<thead>
<tr>
<th>Corporation</th>
<th>Debt (face value B), D</th>
</tr>
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<tbody>
<tr>
<td>Operating Assets, A</td>
<td></td>
</tr>
<tr>
<td>Common Stock, E</td>
<td></td>
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</table>

- In default, the holder of the guarantee receives promised value of the debt minus value of assets recovered from defaulting entity = \( \max [0, B-A] \)
- Value of guarantee = put option on the assets of borrower
- Credit default swaps are guarantees of debt and therefore are essentially put options on the assets of the borrower
Non-linear Credit Risk Buildup

**CORPORATE/HOUSEHOLD SECTOR LIABILITY**

Firm/Mortgage Debt

**BANKING SYSTEM LIABILITY**

Firm/Mortgage Debt Guarantee

**GOVERNMENT LIABILITY**

Bank Deposit Guarantee

Corporate/Housing Assets, \( A_C \)

Bank Assets, \( A_B \)
Feedback Loops of Risk from Explicit and Implicit Guarantees Creating Connectedness

An adverse feedback loop ties sovereigns stresses to banking sector challenges

DOMESTIC

SOVEREIGN

E. Similar sovereigns come under pressure

B. Increase in bank funding costs

C. Erosion in potential for official support

A. Mark-to-market fall in value of govt bonds held by local banks

I. Increase in contingent liabilities of govt.

FOREIGN

SOVEREIGN

D. Mark-to-market fall in value of govt bonds held by foreign banks

G. Rise in counter-party credit risk

H. Withdrawal of funding for risky banks

F. Contagion channels (A, B, & C as above)

Source: IMF GFSR 2010, October, Dale Gray.
Data on Connectedness of Credit Risk

• Sample: January 2001– January 2014
• Monthly frequency
• Entities:
  – 17 Sovereigns
  – 63 Banks
  – 39 Insurance Companies
• Moody’s KMV CreditEdge and CDS Market
Connectedness July 2004–June 2007: Sovereigns, Banks, and Insurance Companies
Connectedness April 2009–March 2012: Sovereigns, Banks, and Insurance Companies
Connectedness to Italy: March 2012

Blue Insurance
Black Sovereign
Red Bank
Greece, Ireland, Italy, Portugal and Spain: GIIPS

From GIIPS minus To GIIPS

Number of Out Degrees Minus Number of In Degrees for GIIPS Countries
Unified Macrofinance Framework Targets

- Inflation, GDP, financial system credit risk, sovereign credit risk

**Financial Stability Policies:**
- Capital adequacy
- Financial regulations
- Economic capital

**Monetary Policies:**
- Policy rate
- Liquidity facilities
- Quantitative actions

**Fiscal and Debt Policies:**
- Fiscal policy
- Debt management
- Reserve management

**Diagram:**
- Household CCA Balance Sheet(s)
- Financial Sector CCA Model
- Financial System Credit Risk Indicator
- Monetary Policy Model
- Central Bank
- Sovereign CCA Balance Sheet Model
- Sovereign Credit Risk Indicator
- Sovereign Debt Risk
- Global Market Claims on Sovereign
- Interest Rate Term Structure
- Guarantees

Date: Gray 2011.
Traditional Flow and Accounting Framework

No risk-adjusted balance sheets (asset volatility = 0)
No credit risk or guarantees; No risk exposures

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Fiscal and Debt Policies:
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Household Accounting Balance Sheet(s)

Bank Accounting Balance Sheets

Monetary Policy Model

Central Bank

Government Accounts Flow of Funds

Global Market Flows

Interest Rates

Capital Injections

Credit Flows

Corporate Accounting Balance Sheet(s)
References


December 2008: Cut rates to record lows.

March 2009: Will keep rates close to zero for “extended period.”

August 2011: Will keep rates extremely low “at least until 2013.”

September 2012: Low “at least until 2015”

December 2012: Will tie low rates to range in unemployment (>6.5%) and inflation (<2%).
USA Risk Neutral Density for 3-Month LIBOR in 3 Years as of June 30, 2008 and December 31, 2008

Bernanke's Fed Drove Short Rates to Near Zero
Computed for Delta Payoffs from Butterfly Spreads of Time Spreads of Interest Rate Caps and Floors

USA Risk Neutral Density for 3-Month LIBOR in 3 Years
as of December 31, 2008 and April 30, 2009

March 2009: Fed Says Rates Low for "Extended Period of Time"

Stocks up. Markets do not believe this will be true for 3 years.

Computed for Delta Payoffs from

USA Risk Neutral Density for 3-Month LIBOR in 5 Years
as of December 31, 2008 and April 30, 2009

March 2009: Fed Says Rates Low for "Extended Period of Time"
Stocks bouncing back. Rate distribution for 5 years shifts to right.

Computed for Delta Payoffs f


USA Risk Neutral Density for 3-Month LIBOR in 5 Years
August 2011: Fed Says Rates Low "At Least Through 2013"
Specificity, long commitment transforms 5-year distribution.

Computed for Delta Payoffs
USA Risk Neutral Density for 3-Month LIBOR in 5 Years
as of December 31, 2012.

Dec 2012: Fed Ties Low Rates to Unemployment >6.5%, Inflation<2.0%,
January 2013 stock surge bulges rate distribution in 2%-4% range. Low tail risk.

Computed for Delta Payo