The Mortgage Crisis and the Role of Financial Engineering:

Confessions of a Financial Engineer Wannabe

Remarks to UF Master of Science in Financial Engineering Program

October 1, 2010
Financial engineering has been integral to the growth and success of mortgage finance

• Mortgage cash flows are highly complex and volatile
  – Interest rate risk
  – Prepayment risk
  – Credit risk
  – Mortgage servicing rights (IO strip, operational costs, payment float, cash flow advancing)

• Management of mortgage risk requires sophisticated financial engineering because of complex embedded options.
  – Prepayment option
  – Default option
  – Interest rate caps and floors
  – Payment options

• Key tools:
  – Securitization – perhaps most powerful force in mortgage finance during my career.
  – Liability management
  – Derivative instruments
  – Insurance
But, the mortgage crisis (and the broader financial crisis) exposed issues with how far financial engineering had gone.

- Multiple “layers” of financial engineering in mortgage market:
  - Layer #1 – The mortgage loan
  - Layer #2 – Securitization (complex and multiple levels)
  - Layer #3 – Derivatives on the securities
  - Layer #4 – Entities investing in the securities and derivatives

- Risks increased at each step due to:
  - Complexity
  - Leverage
  - Total size of the exposure relative to economy
  - Fraud and misrepresentation (at times)
  - Inflexibility to deal with change

- The inherent risks of mortgage finance are large and do not go away, but they became larger and more volatile through changes occurring in the housing finance system and capital markets.

Let’s browse through the crisis history and discuss the future...which remains bright for financial engineering in the mortgage market.
Q. Who/What really caused the mortgage crisis?
A. Everyone/Everything involved in mortgages

- Every major actor in the market made mistakes:
  - Monetary policy
  - Government housing policy
  - Government Sponsored Enterprises (Fannie Mae, Freddie Mac, Federal Home Loan Banks)
  - Borrowers
  - Brokers
  - Rating Agencies
  - Wall Street
  - Large Global Banks
  - Hedge Funds
  - Need I go on??????

A very large collective error was made by society in the housing and mortgage market. Mistakes happen, this one was big.
Interest rate policy in response to Dot.com bubble bursting and 9/11 is an important part of the crisis story.
Lower mortgage rates mixed with growing confidence that home prices could only rise, influenced by nearly a decades worth of steady appreciation.
Borrowing and lending practices shifted significantly in response to steadily rising home prices and lower rates

- Subprime loans boom
- Alt A loans expand as share of market
- Speculative demand for housing – investment demand grows relative to ownership demand

Borrowers shift to ARM loans from traditional fixed rate loans, despite low fixed rates
In response to rising home prices, the mortgage product development financial engineers began to design complex mortgage loans that enhanced “affordability”, at least at inception of the loan.

Many of the current products in the market today provide for a low payment with increased payment shock over time

<table>
<thead>
<tr>
<th>Loan Type</th>
<th>Start Rate</th>
<th>P &amp; I Payment (Initial)</th>
<th>P &amp; I Payment (First Adjustment)</th>
<th>P &amp; I Payment (Maximum Adjustment)</th>
<th>Qualifying Max. Loan Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option ARM (w/ Neg. Amortization)</strong></td>
<td>1.00%</td>
<td>$482.46</td>
<td>$876</td>
<td>$1,912</td>
<td>$285,714</td>
</tr>
<tr>
<td>3/1 IO ARM</td>
<td>5.00%</td>
<td>$625</td>
<td>$904</td>
<td>$1,436</td>
<td>$300,000</td>
</tr>
<tr>
<td>5/1 IO ARM</td>
<td>5.13%</td>
<td>$641</td>
<td>$992</td>
<td>$1,376</td>
<td>$292,683</td>
</tr>
<tr>
<td><strong>30-Yr. Fixed Rate (w/ 2/1 buydown)</strong></td>
<td>4.25%</td>
<td>$738</td>
<td>$826</td>
<td>$916</td>
<td>$254,096</td>
</tr>
<tr>
<td>30-Yr. IO Fixed Rate</td>
<td>6.00%</td>
<td>$750</td>
<td>$1,266</td>
<td>$1,266</td>
<td>$250,000</td>
</tr>
<tr>
<td>5/30 IO (35-Yr.)</td>
<td>6.13%</td>
<td>$766</td>
<td>$911</td>
<td>$911</td>
<td>$244,898</td>
</tr>
<tr>
<td><strong>40-Yr. Fixed Rate</strong></td>
<td>5.75%</td>
<td>$799</td>
<td>$799</td>
<td>$799</td>
<td>$234,571</td>
</tr>
<tr>
<td>5/1 ARM</td>
<td>5.00%</td>
<td>$805</td>
<td>$900</td>
<td>$1,252</td>
<td>$232,852</td>
</tr>
<tr>
<td><strong>30-Yr. Fixed Rate (Approve)</strong></td>
<td>5.63%</td>
<td>$863</td>
<td>$863</td>
<td>$863</td>
<td>$217,143</td>
</tr>
</tbody>
</table>

Assumptions: a) $150K loan amount. b) Start Rates based on posted lender pricing. Rates at adjustment assume current index value for the loan type. Option ARM teaser rate of 1% on IO fixed for one year, then moves to 5.25% until first rate adjustment. c) Qualifying max loan amount for all loan types assumes the borrower made $60K and utilizes a 25% qualifying ratio. d) Option ARM qualifying rate of 5.25%. All other loan types qualified at starting payment rate.
These new mortgage products and features needed a home, and securitization of mortgage assets was critical to enabling this growth, especially through “Private Label” mortgage securities.
Private label securitization of higher risk loans such as subprime mortgages was enabled by innovative financial engineering.

Tranched securitization allocates cash flows to differing credit risk grades and duration preferences.

Source: IMF staff estimates.
Note: CDO = collateralized debt obligation.
Clever structuring combined with rating agency views of the benefits of diversification enabled lower rated securities to be transformed into higher rated securities.
In response to growing size of U.S. residential private label securities market, financial engineering techniques developed for other markets create derivative instruments to be used as mortgage hedging and trading vehicles.

- Credit default swaps on private label mortgage backed securities start to trade in mid 2000’s
- Popularity and transparency of derivative trading enabled by development of indices that track pricing of private label securities called ABX indices – launched January 2007.
Structured mortgage loans went into structured mortgage securities and then were bought by “structured” investment vehicles

- **SIVs** – structured investment vehicles set up by banks.
  - About $400 billion in investments at start of crisis
  - The old “carry trade” – buy long term assets and fund at short-end of the curve.
  - Assets generally were thought the be “safe” securities
- Other vehicles existed such as Asset Backed Commercial Paper Conduits
- Risks = liquidity and solvency

### Features of Typical Conduits, SIVs, and SIV-Lites

<table>
<thead>
<tr>
<th>Features</th>
<th>Conduit</th>
<th>SIV</th>
<th>SIV-Lite</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assets</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US$ = 1,400 billion</td>
<td></td>
<td>US$ = 400 billion</td>
<td>US$ = 12 billion</td>
</tr>
<tr>
<td>Nontradable loans</td>
<td></td>
<td>Assets are traded</td>
<td>Assets are traded</td>
</tr>
<tr>
<td>Less risky</td>
<td></td>
<td>Less risky</td>
<td>Risky</td>
</tr>
<tr>
<td>47% Traditional assets</td>
<td></td>
<td>= 28% Financial institutions’ debt</td>
<td>= 96% U.S. RMBS</td>
</tr>
<tr>
<td>53% Securities and derivatives</td>
<td></td>
<td>= 48% CMBS/RMBS/ABS</td>
<td>= 4% CDOs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>= 22% CDOs/CLOs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>= 2% Other</td>
<td></td>
</tr>
<tr>
<td><strong>Liabilities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100% Commercial paper</td>
<td></td>
<td>27% ABCP</td>
<td>Commercial paper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>66% Medium-term notes</td>
<td>Medium-term notes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7% Capital notes</td>
<td></td>
</tr>
<tr>
<td><strong>Credit enhancement</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Varied (sponsoring bank)</td>
<td></td>
<td>Overcollateralization</td>
<td></td>
</tr>
<tr>
<td><strong>Liquidity facility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractual 100% coverage</td>
<td></td>
<td>Contractual &lt; outstanding liabilities</td>
<td>Partial contractual credit line; subject to market value tests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>= 10 to 15 percent of senior debt</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Brunnermeier (2007); and IMF staff estimates.

The securities market was often financed with repo, exposing leveraged players to a liquidity crisis driven by falling asset prices and increased equity requirements by repo lenders.

- Repo “haircuts” represent the amount of equity needed to finance an asset.
- Haircuts widened dramatically through the crisis.
- Note the breadth of asset classes reflected on the chart. Highlights the degree of innovation in new asset and security classes during the mortgage and credit boom.

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>January-May 2007</th>
<th>April 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. treasuries</td>
<td>0.25</td>
<td>3</td>
</tr>
<tr>
<td>Investment-grade bonds</td>
<td>0-3</td>
<td>8-12</td>
</tr>
<tr>
<td>High-yield bonds</td>
<td>10-15</td>
<td>25-40</td>
</tr>
<tr>
<td>Equities</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Investment grade CDS</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Synthetic super senior</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Senior leveraged loans</td>
<td>10-12</td>
<td>15-20</td>
</tr>
<tr>
<td>2nd lien leveraged loans</td>
<td>15-20</td>
<td>25-35</td>
</tr>
<tr>
<td>Mezzanine level loans</td>
<td>18-25</td>
<td>35+</td>
</tr>
<tr>
<td>ABS CDOs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAA</td>
<td>2-4</td>
<td>15</td>
</tr>
<tr>
<td>AA</td>
<td>4-7</td>
<td>20</td>
</tr>
<tr>
<td>A</td>
<td>8-15</td>
<td>30-50</td>
</tr>
<tr>
<td>BBB</td>
<td>10-20</td>
<td>40-70</td>
</tr>
<tr>
<td>Equity</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>AAA CLO</td>
<td>4</td>
<td>10-20</td>
</tr>
<tr>
<td>AAA RMBS</td>
<td>2-4</td>
<td>10-20</td>
</tr>
<tr>
<td>Alt-a MBS</td>
<td>3-5</td>
<td>20-50</td>
</tr>
</tbody>
</table>

Sources: Citigroup; and IMF staff estimates.
Note: ABS = Asset-backed security; CDO = collateralized debt obligation; CDS = credit default swap; CLO = collateralized loan obligation; RMBS = residential mortgage-backed security.
The result of these and other factors was a home price “bubble” that crashed to very bad economic consequences.
At the cost of a very large toll on households, economic activity and the financial sector.

Foreclosures skyrocket

Construction plummets

Home sales collapse

Steep financial losses
Interestingly, those in search of real root causes may have to address why the housing “bubble” was not just a U.S. phenomena.

Many housing markets around the globe saw large appreciation, many in excess of US home price growth.
Where were the “risk managers”?

- Question – what is the role of “risk management”? Some possible answers:
  1) **Part of business unit, helping business unit leaders manage risk** – if so, we know what happened. Business unit priorities such as profits, volume, client satisfaction, market share and growth took precedence in many organizations.
  2) **Co-equals with the business unit leaders** – if so, who broke the ties and made the final risk decisions? What were the motivations and priorities of the people that decided?
  3) **Final and absolute deciders on risk matters** – if so, does that make the Head of Risk the CEO? If the Head of Risk disagrees in a major way with the CEO, how long does he/she stay in the job?
  4) **Independent oversight** – if so, for whom? The CEO? The Board? Do they understand the risks? Do they have time to absorb the details and engage? Will they favor risk, or other priorities and objectives?

- Some observations from the front lines:
  - The worst time to be a risk manager is in a crisis. The second worst is during the boom.
  - Risk managers operate within the culture, values and risk appetite norms of the organization.
  - It is critical that business unit leaders be held accountable for risk, not just risk management.
  - When the risks are long tailed and take years to be realized, measuring performance and creating proper incentives is difficult.
  - Many of these issues were not about risk – they were about uncertainty.
The changes occurring in the mortgage market transformed the issues faced by risk managers from managing “risk” to managing “uncertainty”

- Frank Knight (1921) identified the distinction between risk and uncertainty.
  - Risk = quantity susceptible of measurement
  - Uncertainty = non-quantitative type

- The distinction is important.
  - Risk can be measured and fairly priced.
  - Uncertainty cannot be.
  - New mortgage products, with never before seen combinations of risk factors, created uncertainty

- Risk manager techniques for managing uncertainty:
  1. Avoid the risk (the traditional risk manager saying “no”).
  2. Keep the risk very small (e.g. limit clients, limit volumes)
  3. Do the business but transfer or hedge some of the risk – through financial engineering.

Managing Uncertainty With Financial Engineering

1) Purchase only senior tranche of a security (e.g. AAA or AA rated)
2) Hedge via a derivative – Credit Default Swap
3) Purchase insurance – Bond insurance or mortgage insurance

Many of the financial engineering techniques discussed in this presentation were legitimate tools for the reduction of risk and uncertainty

But, the bubble was so large, the margin of safety built into these approaches was overwhelmed
Where do we go from here? One Gator’s story:

- **When was the market peak?**
  - Home sales peaked in 2005
  - Depending on the house price index, home prices peaked in 2006 or 2007

- **Historical housing market declines take about 3-4 years from peak to trough.**

- **Marzol thought process in summer of 2008:**
  1. HP bottom circa 2010
  2. Capital destruction would be large
  3. Area in need of capital – mortgage credit risk bearing. Nobody wanted the risk, contrarian play.
  4. Look for clean balance sheet opportunities requiring mortgage and financial engineering skills and position for bottom in home prices

- **Opportunity areas –**
  - REIT or distressed mortgage asset fund
  - Mortgage insurance
Private Mortgage Insurance Basics

Private MI Contracts

• Private MI is an insurance contract that protects mortgage investors from credit losses by paying a claim when a loan goes bad
• Typical coverage is 25%
  ➢ $100,000 loan with 25% coverage would get a base claim payment of $25,000 plus interest and expenses
• Risk is backed by private capital
• Industry traditionally insures low down payment mortgages – but in some countries like Canada private MI covers 100% of the risk of loss
• MI is essentially a first loss residual on a low down payment mortgage compensated by an IO strip – this makes it a risk management and financial engineering business at it’s heart.

Industry Basics

• Competitive industry with 8 active players in 2008
• 2008 Thesis - industry capital base would be dramatically eroded, creating opening for new entrant.
• 2010 Reality - industry will pay an estimated $35-50 billion in claims from private capital without a TARP bailout (a “man bites dog story” in the mortgage crisis). One incumbent closed shop, the others have been hurt but still standing.
• High risk/high reward opportunity due to very high barriers to entry, including:
  ➢ Capital
  ➢ State licensing (can take years)
  ➢ Platform
  ➢ Approval by Fannie Mae and Freddie Mac
  ➢ Ratings
  ➢ Lender acceptance
Essent – A Short 3 yr Journey to a New Private Mortgage Insurance Company

2008
- Market Analysis
- Investor Group Identified
- CEO plus small initial management team on-board
- Investor group stays with concept through turmoil of fall of 2008

2009
- Capital raise finalized – currently $600 million
- Senior management team hired
- Platform acquired
- State licensing begun
- Fannie Mae and Freddie Mac Approval process begun

2010
- All approvals and licenses received
- Lender marketing and initiation begun
- Staff exceeds 100 FTE
- First policies written in Q2
- No other new entrants have run the gauntlet, giving Essent a first mover advantage

Parting Thoughts
✓ Private MI startup probably the toughest to pull off in mortgage industry
✓ It was fun being a “controlled” entrepreneur – the energy of a startup but in a regulated business and an environment focused on risk
✓ The future is exciting – but depends on a still uncertain housing market and public policy for housing finance.