

Mortgage Risk Modeling and the Crisis

Presentation to Conference on "Modeling Credit Risk after the
Subprime Lending Crisis"

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Outline

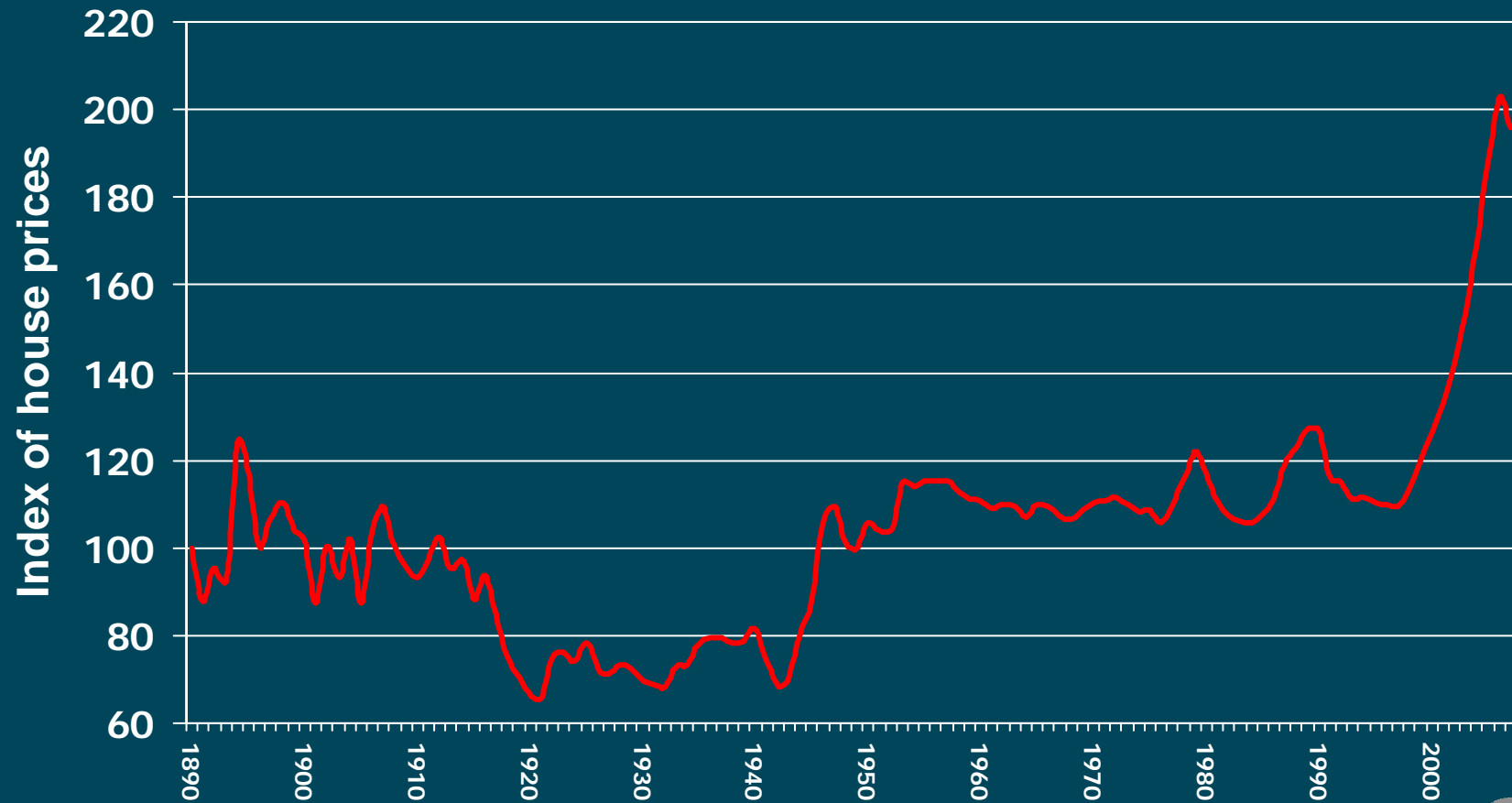
- Economic Fundamentals Leading to the Mortgage Default Crisis
- The Ensuing Financial Crisis
- Model Risk and Risk Management as Causal Factors in the Crisis



Economic Fundamentals of the Mortgage Default Crisis



Greatest Increase in Real Home Prices in U.S. History

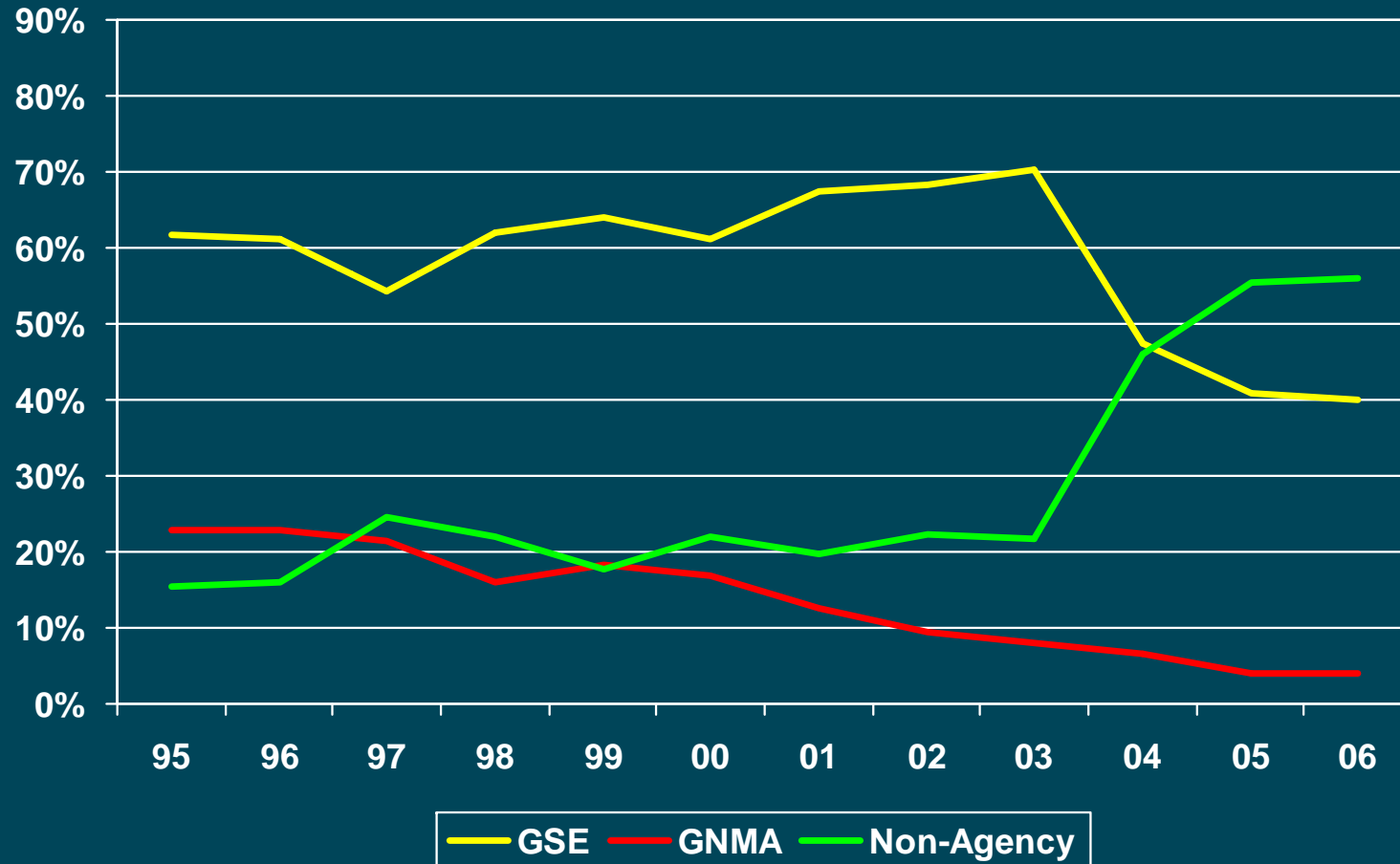


Source: Robert Shiller, Irrational Exuberance



Growth in Private Label Mortgage-Backed Securities Market

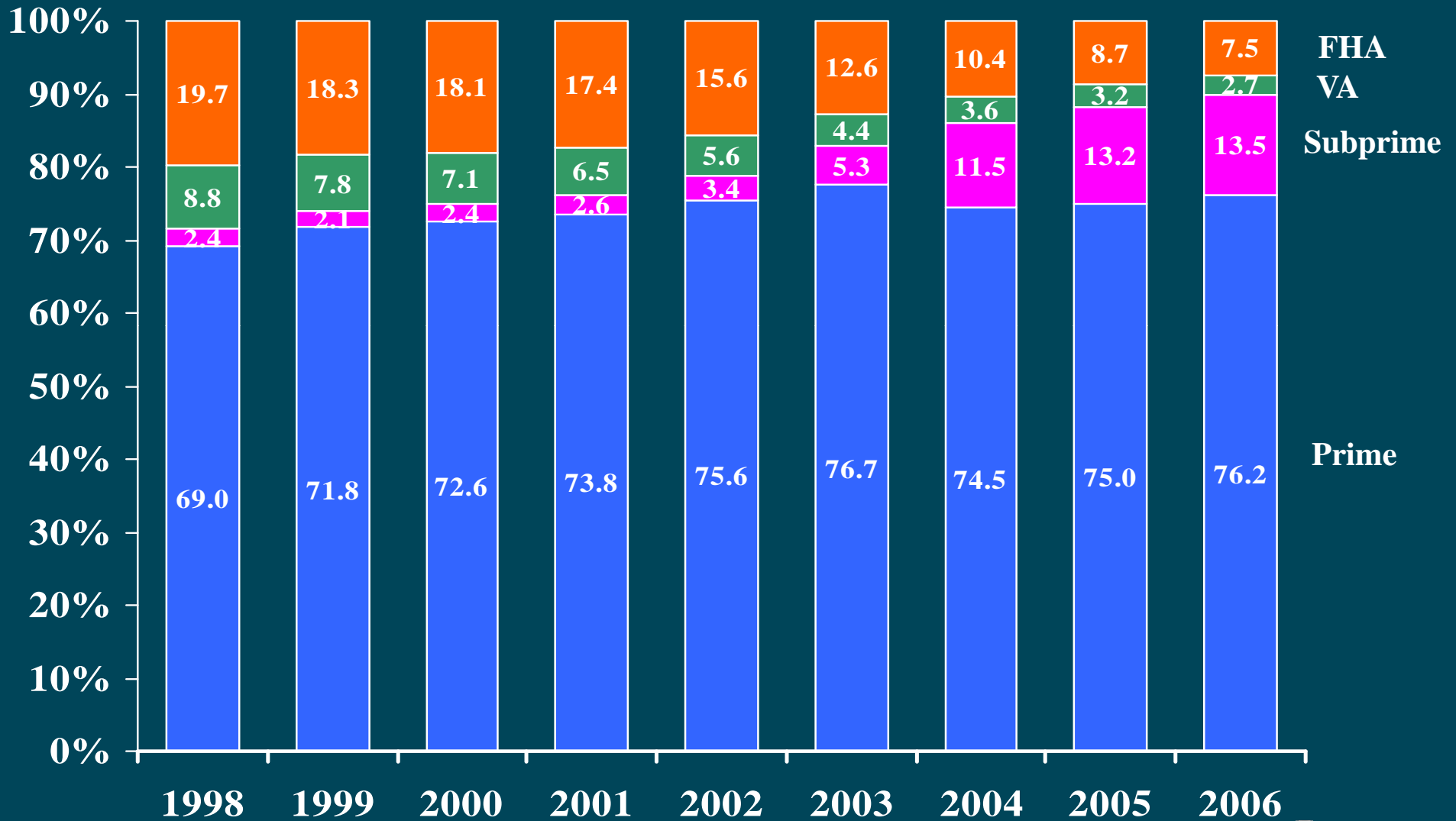
MBS Issuance as a Share of Total MBS Issuance: 1995-2006



Source: The 2008 Inside Mortgage Finance Mortgage Market Statistical Annual—Volume II, p. 9
Note: GSE includes Fannie Mae and Freddie Mac.



Subprime Share of Mortgage Market Grew Rapidly

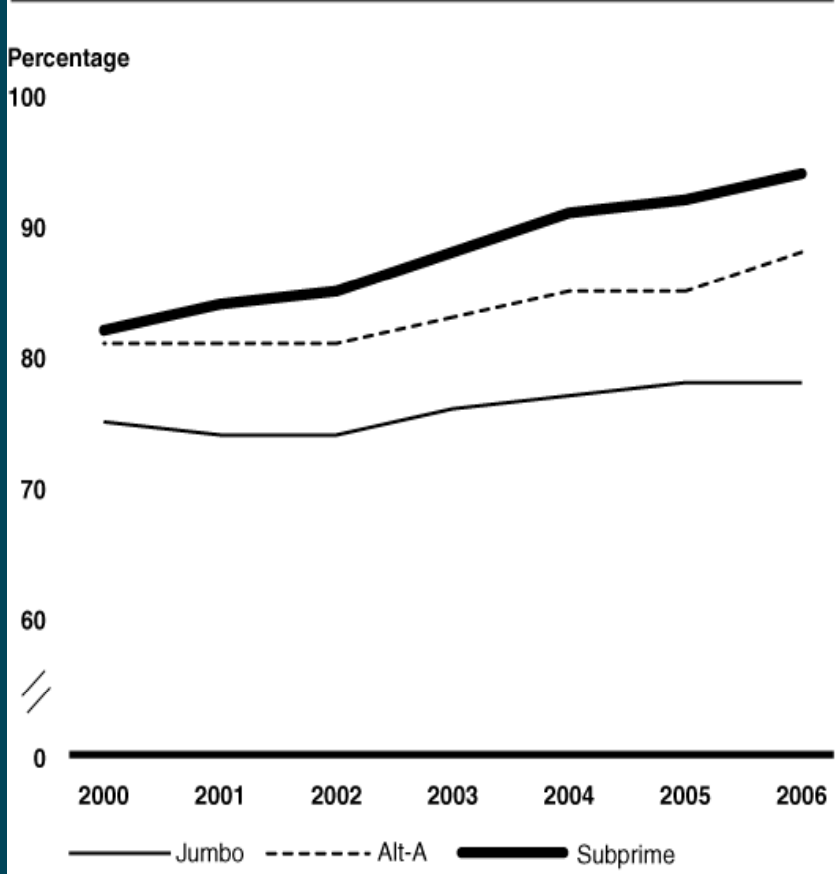


Annual data, 2006 is average of 2006Q1-2006Q3.
 Source: Mortgage Bankers Association

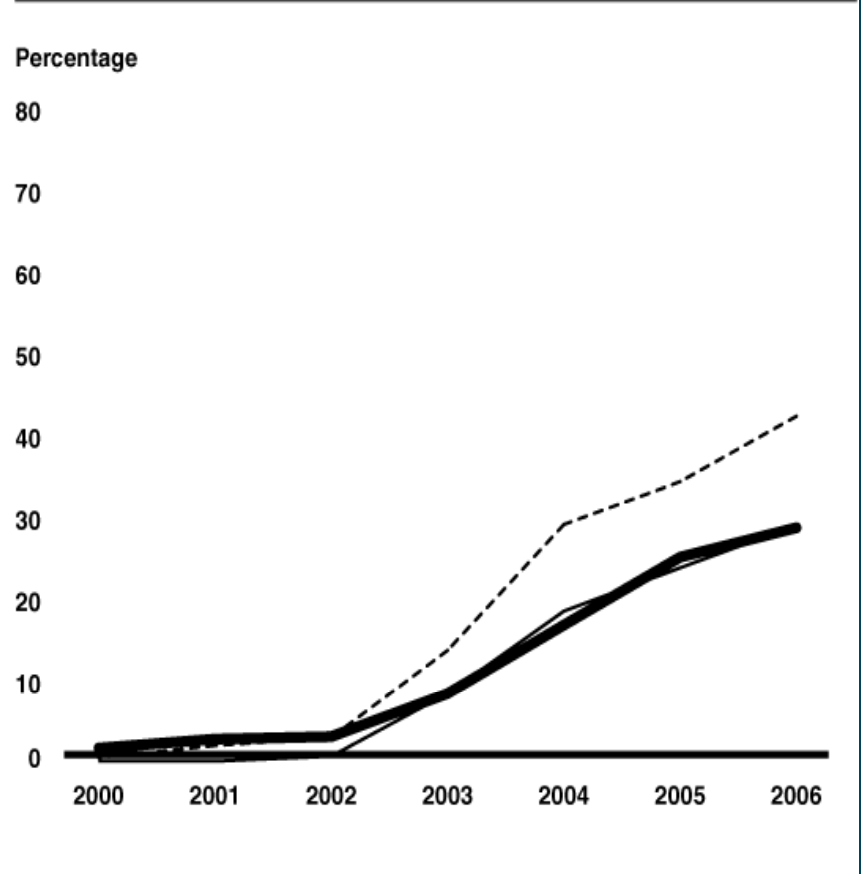


Easing of Underwriting Standards: High Combined Loan-to-Value (CLTV)

Average CLTV ratio (purchase loans only)



Percentage represented by mortgages with piggyback loans

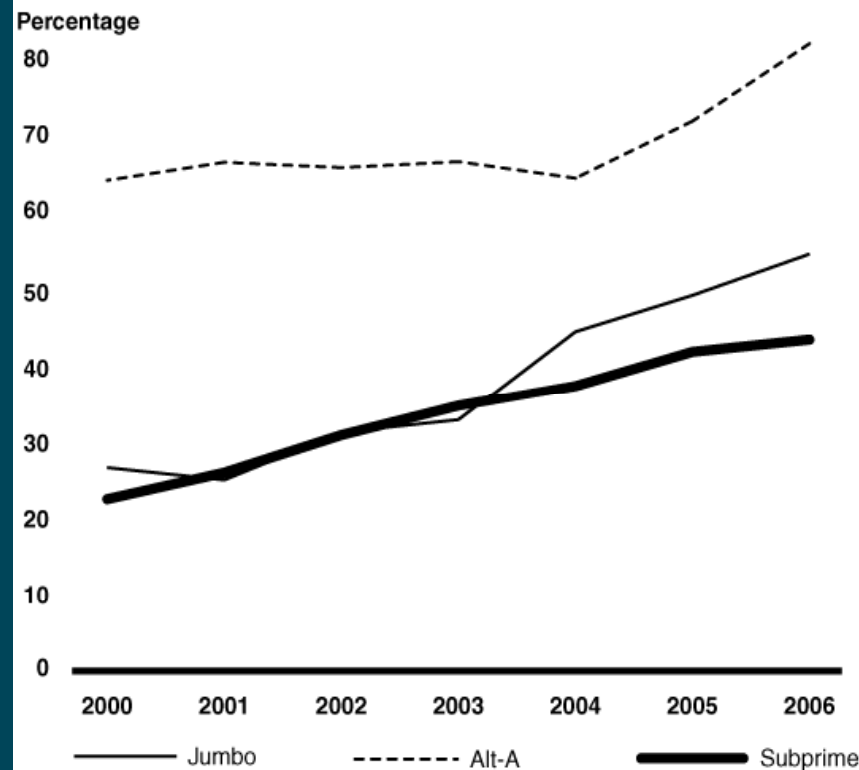


Source: UBS analysis of data from LoanPerformance.

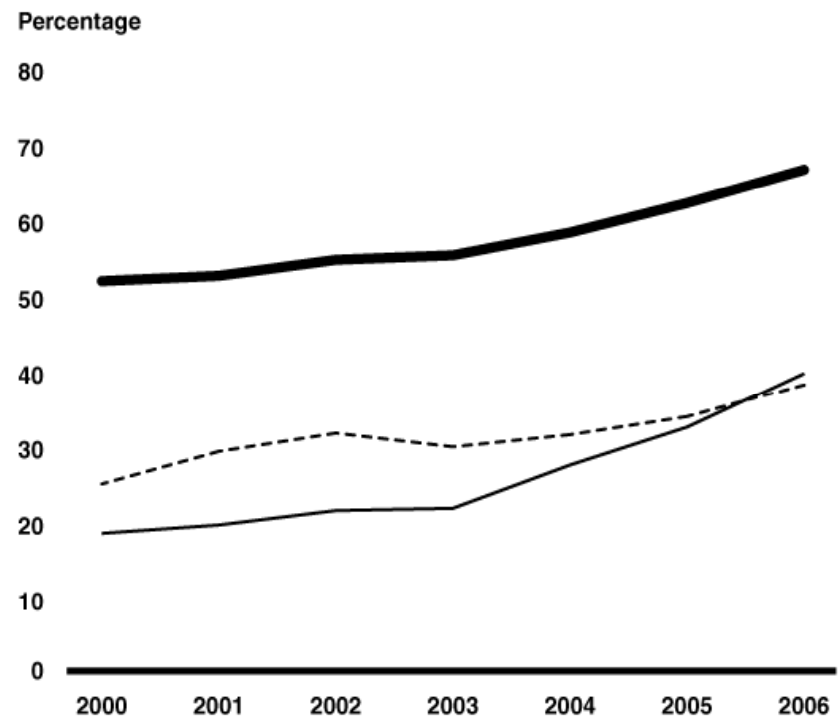


Easing of Underwriting Standards: Low Documentation/High Debt-to-Income

Percentage represented by loans with no or low documentation



Percentage represented by loans with debt service-to-income ratios >40%



Source: UBS analysis of data from LoanPerformance.

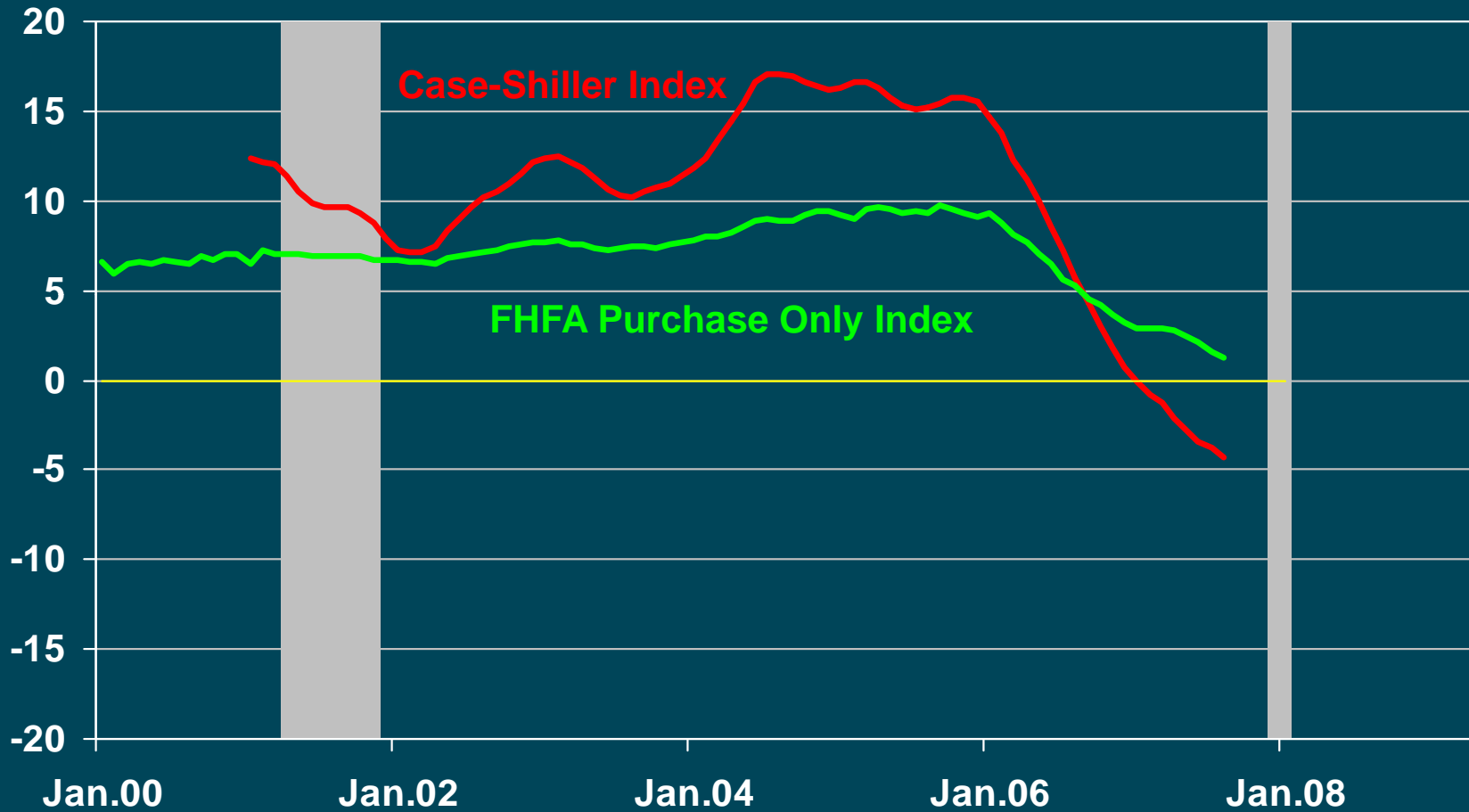


The Mortgage Default Crisis



Home Sales Prices (12-Month Percentage Change)

Percent

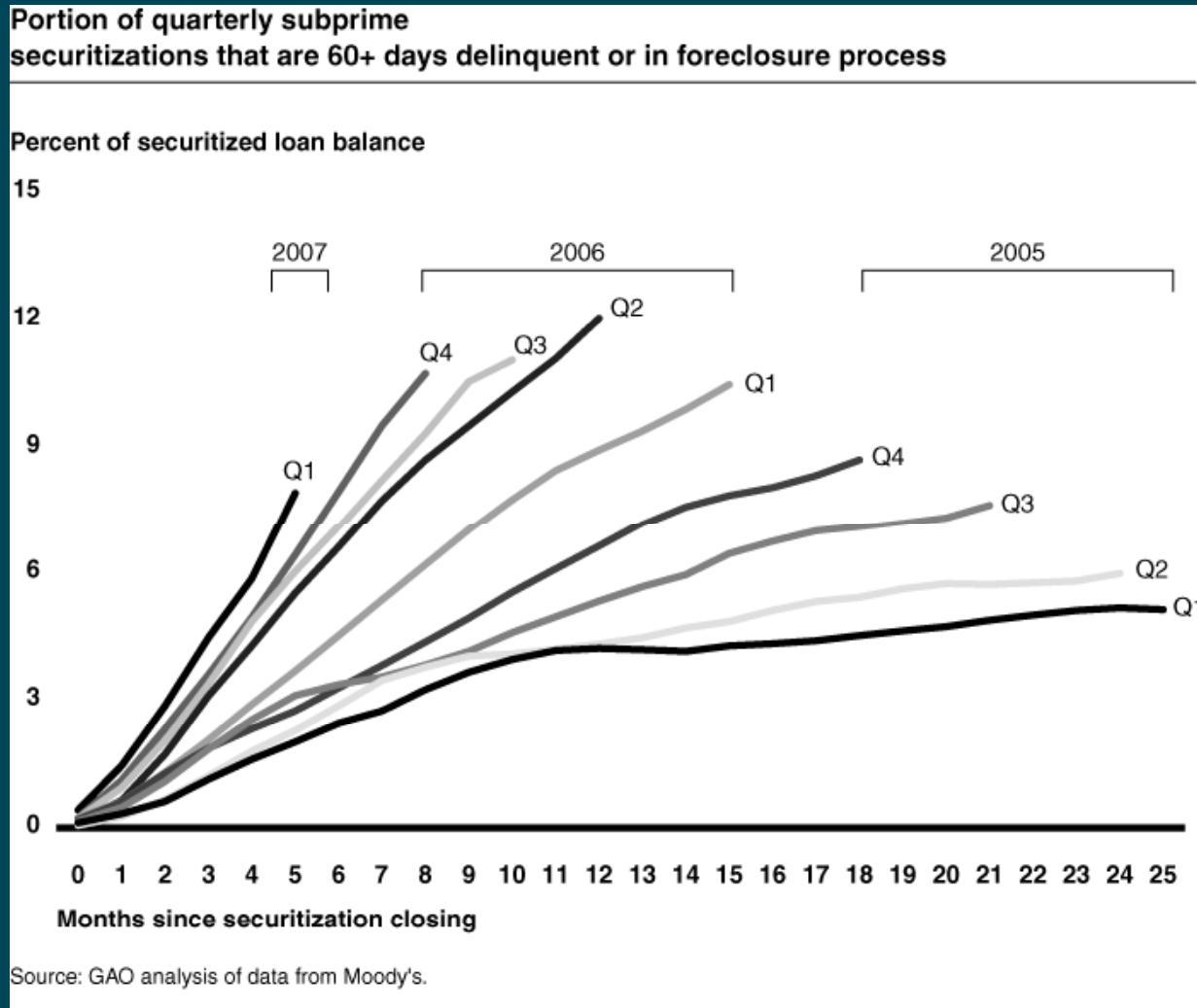


Monthly data: Last point plotted is August 2007.

Source for Existing Homes: National Association of Realtors; April 2009 data

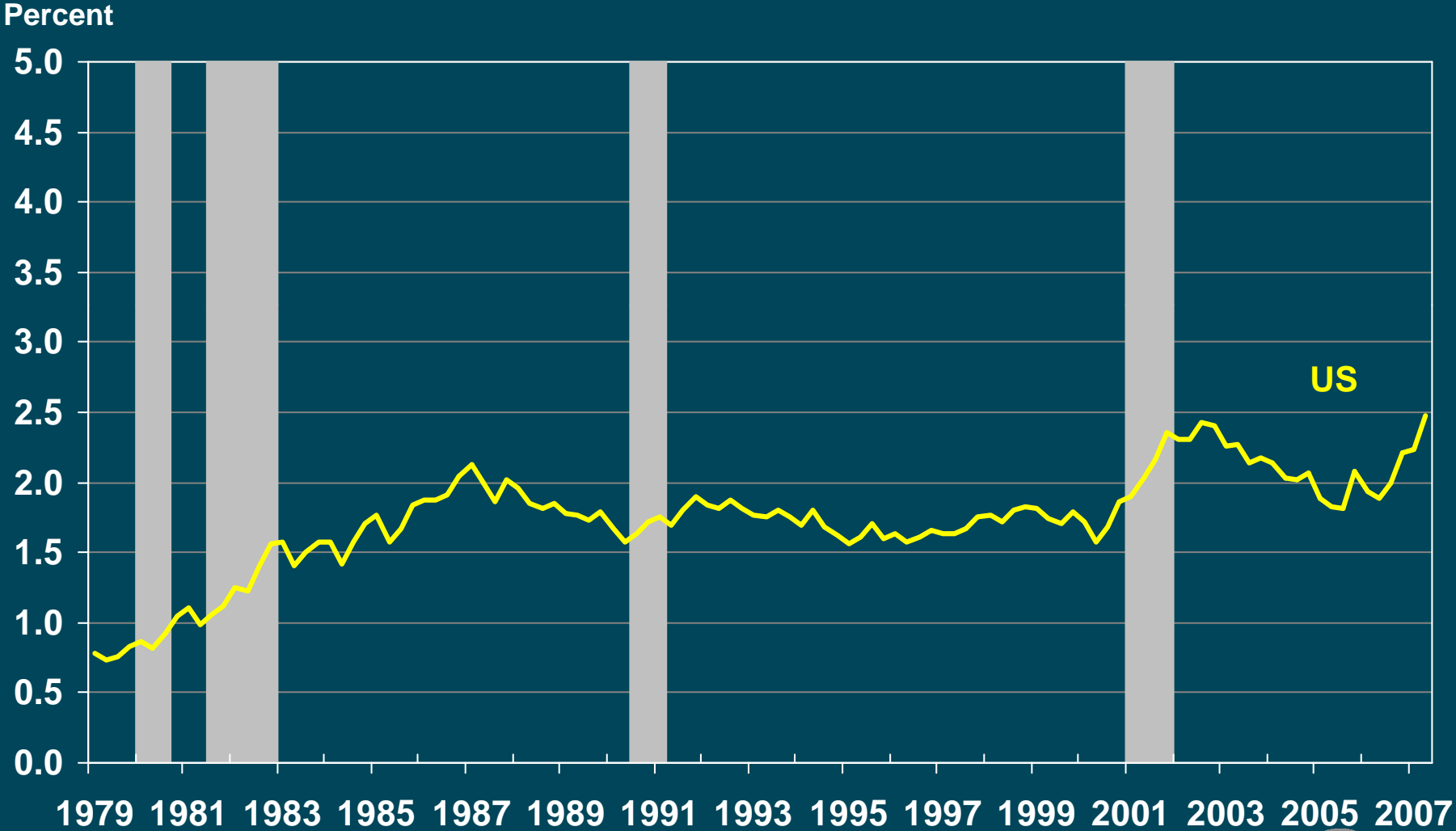


Vintages Systematically Worsening Beginning in 2005



Mortgage Delinquencies Through 2007: Q2

Seriously Delinquent Mortgages



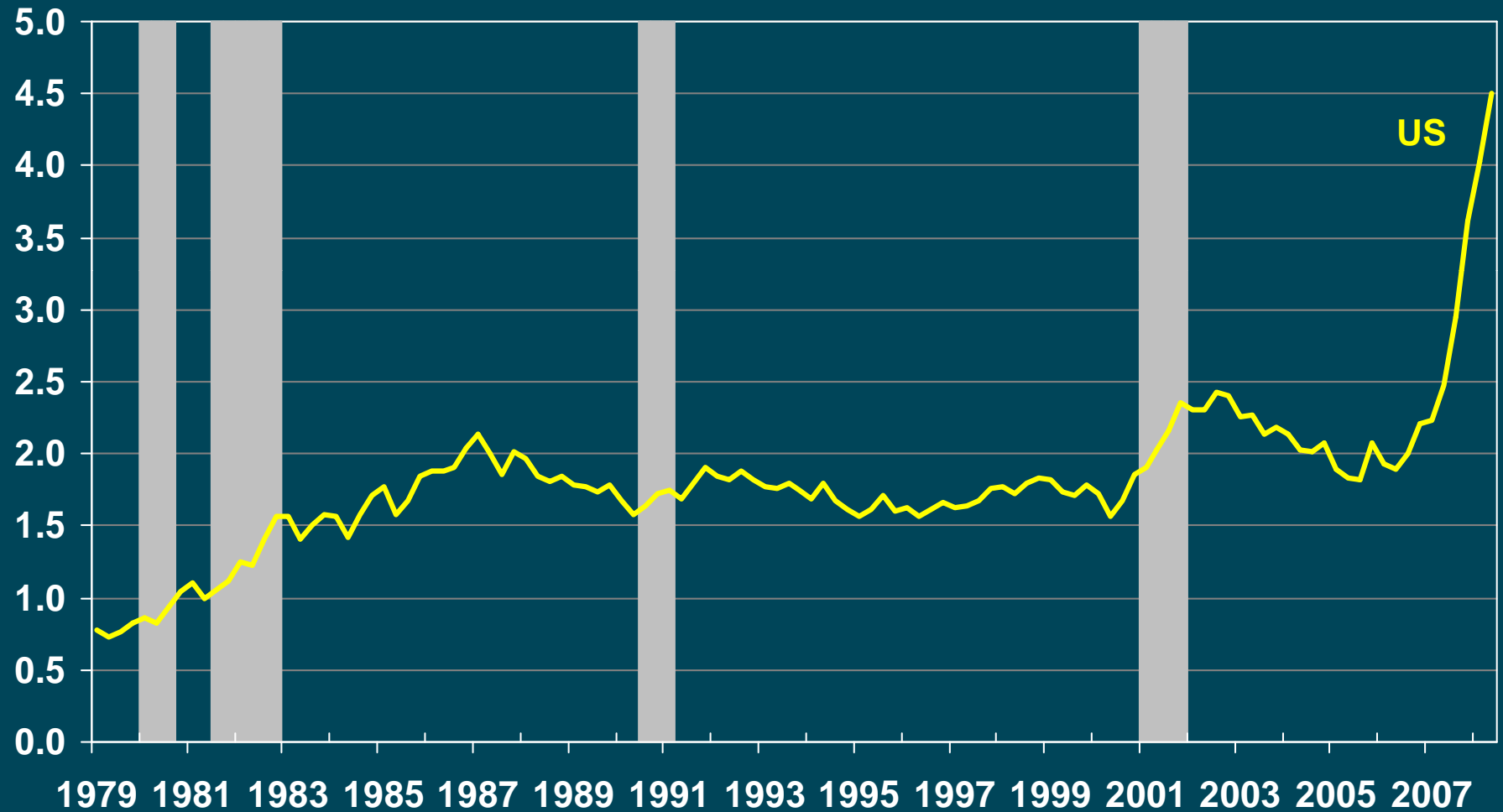
Source: Mortgage Bankers Association



Mortgage Delinquencies Through 2008: Q2

Seriously delinquent mortgages

Percent

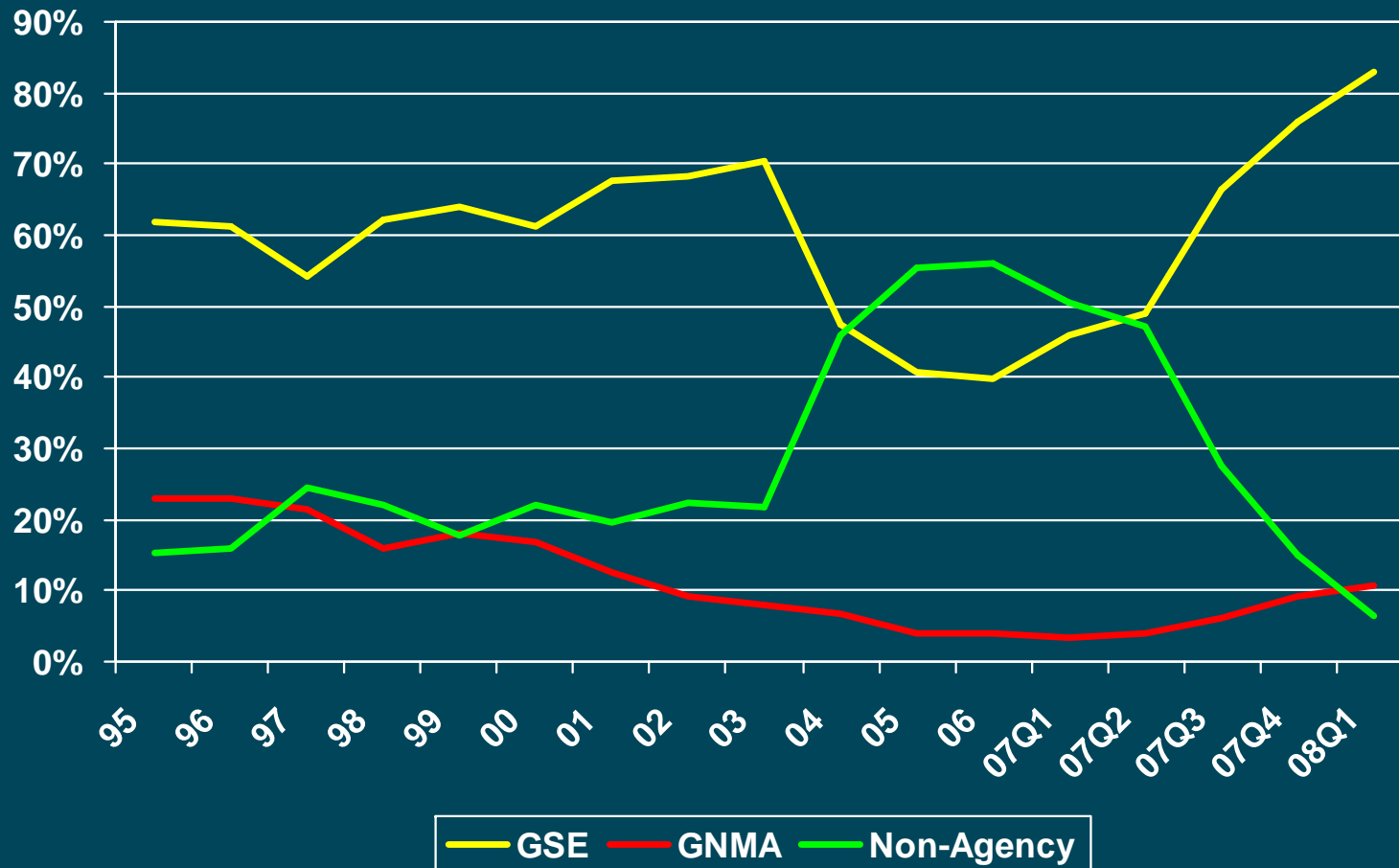


Source: Mortgage Bankers Association



Non-Agency MBS Issuance Shut Down

MBS Issuance as a Share of Total MBS Issuance: 1995-2008Q1



Source: The 2008 Inside Mortgage Finance Mortgage Market Statistical Annual—Volume II, p. 9
Note: GSE includes Fannie Mae and Freddie Mac.



The Financial Market Crisis



Institutions Have Recognized Huge Subprime-Related Losses

**Subprime Related Writedowns and Credit Losses at Commercial Banks, Investment Banks and Thrifts
2007-2008**

| Firm | Writedown | Credit Loss | Total | Firm | Writedown | Credit Loss | Total |
|--------------------------|-----------|-------------|-------|-------------------------|--------------|-------------|--------------|
| Citigroup | 35.3 | 5.6 | 40.9 | Barclays | 3.3 | | 3.3 |
| UBS | 38 | | 38 | WestLB | 3.2 | | 3.2 |
| Merrill Lynch | 31.7 | | 31.7 | Bear Stearns | 3.2 | | 3.2 |
| Royal Bank of Scotland | 14.9 | | 14.9 | National City | 0.5 | 2.6 | 3.1 |
| Bank of America | 9.2 | 5.7 | 14.9 | Goldman Sachs | 3 | | 3 |
| Morgan Stanley | 12.6 | | 12.6 | Dresdner | 2.7 | | 2.7 |
| HSBC | 3 | 9.4 | 12.4 | Nomura Holdings | 2.5 | | 2.5 |
| JPMorgan Chase | 5.5 | 4.2 | 9.7 | ABN Amro | 2.4 | | 2.4 |
| Credit Suisse | 9.6 | | 9.6 | Fortis | 2.3 | | 2.3 |
| IKB Deutsche | 9 | | 9 | HSH Nordbank | 2.3 | | 2.3 |
| Washington Mutual | 0.3 | 8 | 8.3 | Bank of China | 2 | | 2 |
| Deutsche Bank | 7.4 | | 7.4 | LB Baden-Wuerttemberg | 2 | | 2 |
| Wachovia | 4.9 | 2.4 | 7.3 | Natixis | 1.9 | | 1.9 |
| Credit Agricole | 6.5 | | 6.5 | BNP Paribas | 1.3 | 0.3 | 1.6 |
| Mizuho Financial Group | 5.4 | | 5.4 | UniCredit | 1.6 | | 1.6 |
| Canadian Imperial (CIBC) | 4.1 | | 4.1 | DZ Bank | 1.5 | | 1.5 |
| Societe Generale | 3.8 | | 3.8 | Caisse d'Epargne | 1.3 | | 1.3 |
| Bayerische Landesbank | 3.6 | | 3.6 | Gulf International | 1 | | 1 |
| Wells Fargo | 0.9 | 2.7 | 3.6 | Other European banks | 9.4 | | 9.4 |
| E*Trade | 2.5 | 0.9 | 3.4 | Other Asian banks | 6.9 | 0.4 | 7.3 |
| Lehman Brothers | 3.3 | | 3.3 | Other North Amer. Banks | 2.8 | 0.9 | 3.7 |
| | | | | TOTALS* | 268.6 | 43.1 | 311.7 |

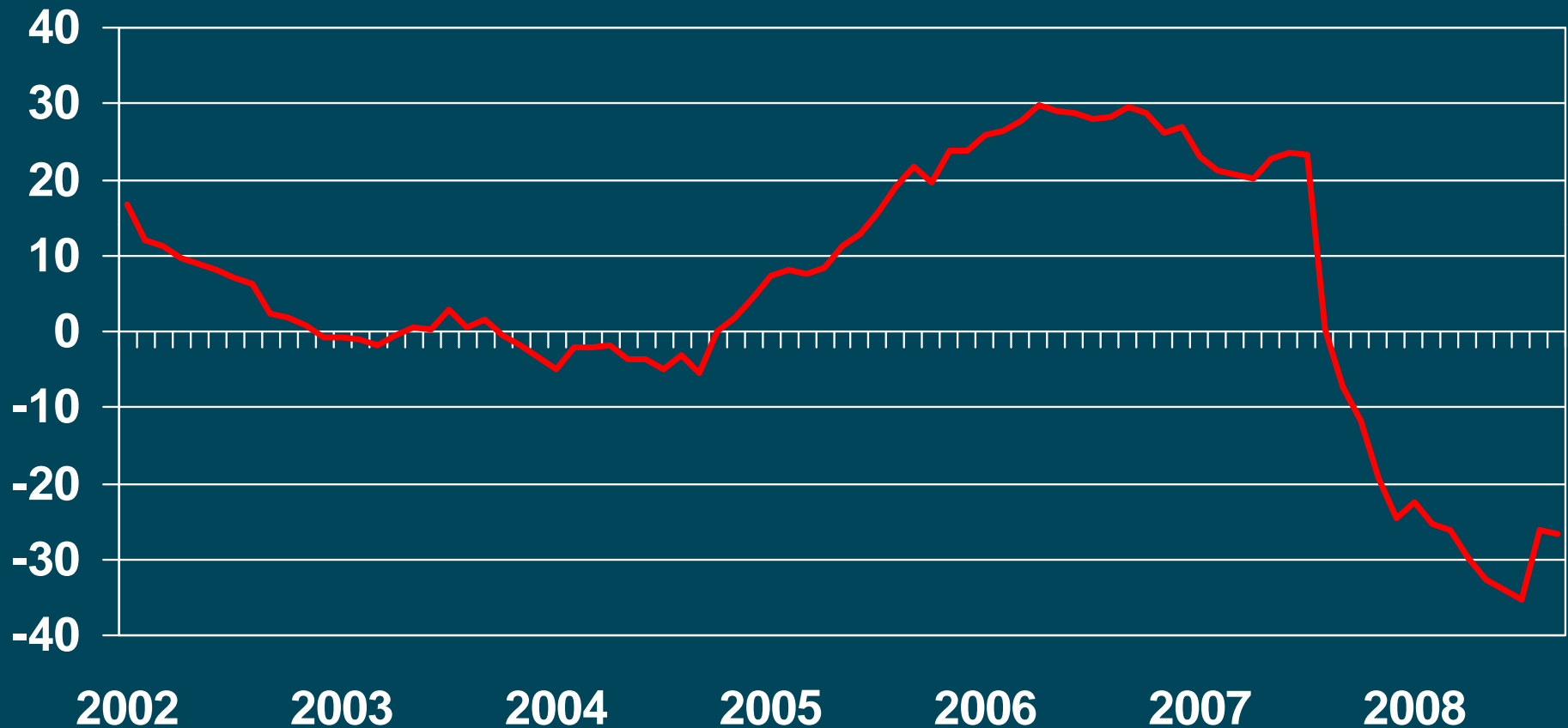
Source: Bloomberg: Subprime Bank Losses Reach \$312 Billion with RBS, Nomura."

Note: Writedowns are mark-to-market losses while Credit Losses are charge-offs and increases in reserves.



Asset-Backed Commercial Paper Plummets in August 2007

% Change in Asset-Backed Commercial Paper Outstanding



Risk Management and Model Risk



Did Model Error or Overreliance on Models Cause the Crisis?

- Argument 1: Financial companies increasingly rely on sophisticated quantitative risk models. Models performed poorly and did not indicate the potential default risk in the subprime market.
- Argument 2: Quantitative models were oversold. They provided bank management a false sense of security that led them to take inordinate risks.



Failures of Risk Management in the Mortgage Crisis

- Irrational exuberance—lenders didn't believe loans were risky because housing prices would continue to rise.
- Analysts/modelers failed to account for supply/demand side changes that affect performance—model error from reduced form models.
 - Originate-to-distribute model changed lender behavior.
 - Housing boom and increased availability of credit led to changes in borrower behavior.
- Large financial firms held enormous concentration of mostly AAA complex structured financial securities. In some cases, companies didn't quantify firm-wide exposure.



Principle Sources of Error in Mortgage Default Modeling

- Unprecedented market conditions
- Rapid growth in new products
- Changes in underwriting
- Growth in non-agency securitization



Time to Event (Hazard) Models

- Behavioral equations
 - Prepayment across product types (fixed rate, different ARM products)
 - Default equations
 - Loss given default equations
- Econometric models for state variables
 - Interest rate process
 - House price appreciation forecast or simulation
- A simulation framework producing expected cash flows/loss distributions



Model Validation Issue

- Hazard model is a combination of a “risk model” and a model of the state variables. It’s important to decompose source of forecast errors in validation process.
- Embedded simulation models of underlying risk factors (e.g., prices, interest rates), particularly correlation factors, are difficult to model.



Structural vs. Reduced Form

- Credit risk models are essentially “reduced form,” not “structural.”
- A true structural model would account for underlying changes in supply/demand behavior including adverse selection.
- The problem is exacerbated by short data history.
- Example: Housing market boom + unprecedented loosening of credit standards may generate changes in the extent of adverse selection or moral hazard issues.



Did the Reduced Form Models Fail?

- The evidence is not yet clear. Surprisingly, the current evidence suggests that conditional forecasts did not perform poorly.
- Willen, Gerardi, Lehnert and Sherland (2009) looked at numerous internal analyses. Find that:
 - Overoptimism about home price appreciation
 - Predictions of large defaults conditional on HPA decline
 - Firms did have “pessimistic” scenarios for HPA with very large defaults similar to actual defaults



Overoptimism on HPA Bank Example, 2005

House Price Scenarios

- 11% HPA over the life of the pool: prob. 15%
- 8% HPA over the life of the pool: prob. 15%
- HPA slows to 5% by year-end 2005 prob. 50%
- 0% HPA for the next 3 years, 5% after: prob. 15%
- -5% for the next 3 years, 5% after 5%: prob. 5%

Note: Over the relevant period, HPA actually came in a little below the -5 percent



Some Observations

- Willen, et al. correctly stress the crucial role that HPA overoptimism played in model error.
- However, overoptimism explains why EL is low, it doesn't necessarily explain why estimates of tail loss are low.
- Many firms included stress scenarios with HPA declines equal or worse than HPA by August 2007.



Some Puzzles

- Puzzle 1: Why did companies fail to respond to high downside risk generated by risk models and mitigate that risk?
 - Loan originators did mitigate the risk through securitization. Most of the losses occurred in securities losses not on-balance sheet loan losses.
 - Incentives of decision makers seem to have been a major factor. It raises the question of whether financial firms have sufficient incentives to avoid tail risk.
- Puzzle 2: Why did the asset-backed securities market collapse in August 2007 if tail risk was accurately projected?
 - Much of the initial problems in ABS market arose from CDOs and more structured products. Linkage to cash flow models was looser for these securities.
 - Models did not consider effect on market liquidity as loss events became more likely.



Some Puzzles

Puzzle 3: Why did firms take such large concentrated investment positions in the mortgage sector?

- Senior Supervisors Group Survey (2008) found that many firms were unable to accurately aggregate their exposures to mortgage related assets.
- This was principally due to complexity of many structured products (Gorton, 2008).
- Misaligned incentives may have been partially responsible for increasing complexity of firms' security holdings.



Some Concluding Thoughts on Model Error and the Mortgage Crisis

- Central issue was overoptimism on HPA not mortgage risk models.
- Modeling problems were more severe in analyzing complex structured products.
- Models of tail risk have been greatly oversold and uncertainties underplayed.
- Nevertheless, the central issues revolved around risk management failures rather than model failures.

