Equity Research
North America

Industry

Mortgage Finance

Kenneth Posner
+1 (1)212 761 4524
Kenneth.Posner@morganstanley.com
David Brown
+1 (1)212 761 0531
David.Brown@morganstanley.com

Industry Overview

July 6, 2005

Fannie Mae, Freddie Mac, and the Road to Redemption

GICS SECTOR	FINANCIALS
US Strategist Weight	21.0%
S&P 500 Weight	20.0%

KEY STOCK RATINGS	
Fannie Mae (FNM, $58.50)	Equal-weight
Freddie Mac (FRE, $65.34)	Overweight

- **Conclusion: New regulatory regime should be less stringent than market fears**
  We look past the current political controversy and predict that a new regulator would raise capital standards for the retained portfolios from 2.5% to 4-5% of assets and restrict risk-taking, significantly reducing their competitive advantage and leaving them with little opportunity to grow. For this scenario, the stocks now look attractively valued.
- **What's New: We turn to the latest in risk theory to anticipate new regulations**
  This is the first public study to present an economic capital framework for measuring interest rate risk of MBS (see pages 18-50). We specifically address GSE critics' concerns, such as fat-tailed interest rate shocks, as well as model, basis, and swap-market liquidity risk.
- **Implication: Upper-teens upside potential to revised price targets for FNM, FRE**
  Our price targets go from $65 to $67 for FNM and from $80 to $77 for FRE. The stocks appear to discount for legislation that would mandate rapid elimination of retained portfolios — a worst-case scenario that we consider unlikely. We favor FRE thinking that, under the new regime, FNM's net interest margin will be significantly pressured.
- **Mortgage finance industry group: Attractive**
  Popular concerns over the risk of a housing "bubble" appear to have left the stocks as a group undervalued.

Please see analyst certification and other important disclosures starting on page 58.

Contents

Please see analyst certification and other important disclosures starting on page 58.

Fannie Mae, Freddie Mac, and the Road to Redemption

Summary and Investment Conclusion

This report attempts to peer through the mists of current political controversy and envision the logical and thus most likely regulatory regime for the government-sponsored enterprises (GSEs), Fannie Mae and Freddie Mac. We conclude the stocks look attractively valued, for anything short of a worst-case scenario for a new regulatory regime. Our expectation that new capital standards will be raised from the current 2.5% to the range of 4-5% is based on our application of the latest best practices in risk-management theory and our reading of the political landscape. This framework also drives our earnings forecasts and valuation targets for Fannie Mae and Freddie Mac, which we have extensively revised. Our price targets change, for Fannie Mae from $65 to $67, and for Freddie Mac from $80 to $77.

With much of the criticism of the GSEs centering on the risk in their retained portfolios, the key to the new regime, in our view, is the establishment of appropriate capital standards. The right capital should neutralize much of the GSEs' competitive advantage, leave them on a level playing field with other financial institutions, and ameliorate concerns that they benefit from governmental subsidy. The right capital should also take away incentives for unbridled growth, mitigate concerns over systemic risk, and thus make extreme measures, like elimination of their portfolios, unnecessary.

The body of this study is an economic capital framework, which allows us not only to estimate the right capital standard under traditional regulatory definitions, but also study some of the special risks that GSE critics have called attention to, including the possibility of fat-tailed interest rate shocks, as well as model, basis, and swap markets liquidity risk.

We predict that a new regulator will significantly raise capital standards for the retained portfolios and impose additional constraints on risk-taking. To be precise, we expect the regulator to raise the minimum capital ratio to 4-5% of assets, up from a current level of 2.5%. Additionally, we expect the regulator to impose limits on risk-taking, for example, requiring higher levels of purchased options (especially at Fannie Mae), so as to minimize the need for dynamic hedging, a key concern of Federal Reserve Chairman Alan Greenspan. The regulator might also limit their heavy use of short-term debt, current levels of which would be imprudent, in our view, if the firms were fully private. With the power to force shrinkage in the GSEs' portfolios in the name of safety and soundness, the new regulator should have sufficient authority to enforce these limitations.[1]

Level playing field will likely be a guiding principle for a new regulator. Implicit in our thinking is the assumption that a new regulator will view its job as "rehandicapping" the GSEs, so they operate on a level playing field with other financial institutions. A minimum capital standard of 4-5% would bring the GSEs in line with US banking standards, where the leverage ratio requires 5% tangible equity to assets for an institution to be classified as "well capitalized." We also assume that the new regulator approaches this important decision in a spirit of compromise, rather than bent on placating hardline GSE critics. The new regulator will not likely care to impose arbitrary limits on the size or growth of the portfolio, in our view, as this approach is alien to the US regulatory tradition.

Tighter regulatory standards would substantially reduce the GSEs' competitive advantage and returns, thus limiting the growth opportunity. Fannie and Freddie's competitive advantage has already eroded, as is evident in the slow and uneven growth of their retained portfolios in recent years. The causes of the erosion include a narrowing of their funding cost advantage, the imposition of monthly risk disclosures, and the emergence of banks and other investors as aggressive competitors for MBS assets. Under the new regulatory regime we envision, Fannie and Freddie's retained portfolios will generate returns on equity of 10-12%, down from historical returns in excess of 20%. We expect the portfolios to remain flat, neither growing nor shrinking, as Fannie and Freddie focus on preserving their margins. This part of the GSEs' business will be worth only a modest premium to book value.

[1] "The Director may by order require an enterprise, under such terms and conditions as the Director determines to be appropriate, to dispose of or acquire any asset or liability, if the Director determines that such action is consistent with the safe and sound operation of the enterprise or with the purposes of this Act or any of the authorizing statutes." Amendment in the Nature of a Substitute to H.R. 1461, Offered by Mr. Oxley of Ohio, p. 50.

Please see analyst certification and other important disclosures starting on page 58.

For investors, the stocks look attractively valued, for anything short of a worst-case scenario. Exhibits 1 and 2 show a range of estimated stock prices for Fannie Mae and Freddie Mac as a function of capital ratios and growth rates for the retained portfolios. In prior years, before the current accounting and political controversy, when we expected double digit portfolio growth at the current 2.5% capital standard, we viewed the stocks as worth $90–100 or more. Looking ahead, under the new regulatory regime, with the portfolios capitalized at 4.5%, Freddie Mac is worth $77 and Fannie Mae $67, according to our models, offering around 20% upside potential including dividends. These price targets value the retained portfolios at 1.2-1.5x book value and the credit guarantee businesses at 2.1-3.0x book value.

In a worst-case scenario, where legislation mandated the rapid run-off of their retained portfolios to levels of $100-$150 billion, the stocks would show little downside, according to our analysis (Exhibits 1 and 2). This is a conservative scenario, because to model portfolios this small within the next five years requires a run-off rate assumption in excess of 40%. If interest rates were to rise, a run-off assumption closer to 10% would be more realistic, and in a scenario of gradual shrinkage, rather than immediate run-off, the stocks might offer modest upside potential. For what it's worth, we do not foresee Congress agreeing on such an extreme piece of legislation, nor do our political contacts in Washington.

Legislation is a possible positive catalyst... With regard to investor psychology, we view the enactment of legislation as a positive catalyst for the stocks. Earlier this year, with the 65-5 passage of a House bill out of subcommittee, the odds for new legislation seemed favorable. More recently, controversy has erupted over an affordable housing tax provision favored by Democrats. And the White House and Republican Senators continue to argue for portfolio limits. The outlook has become less clear. With the Senate now focusing on Supreme Court appointments, GSE legislation seems more likely as a 2006 priority. Even then, it is not clear how the House and Senate would reconcile their bills in a form that was acceptable to the White House. The final outcome, we believe, is the new regulatory regime we describe in this report; how long it will take the political process to get there is hard to know.

…But political stalemate would allow the firms to keep earning high returns. If Congress is unable to agree on new legislation, then no doubt a cloud of uncertainty will continue to surround the stocks. But without new legislation, the GSEs will operate under the existing regime, and every year of delay means another year where higher returns and faster growth are still legally possible. As such, the stocks should mathematically be worth more if legislation is delayed. For example, if we assume legislation is passed in 2006 instead of 2005, our Freddie Mac price target would increase from $77 to $80.

Exhibit 1

Fannie Mae: Sensitivity of Price Target to Retained Portfolio Assumptions

FNM - Price Target - New Regime

Growth	Capital Requirement (%)					
(07-09) (%)	2.5	3.0	3.5	4.0	4.5	5.0
10	$87	$84	$80	$77	$74	$71
5	$82	$79	$76	$74	$71	$69
0	$77	$75	$73	$71	$67	$66
-5	$74	$72	$70	$68	$66	$64
-10	$71	$69	$68	$66	$64	$63
:	:	:	:	:	:	:
-40	$59	$59	$58	$58	$57	$57

Base Case

Worst Case

Assumes GSE legislation passed by year-end 2005, new regulatory regime implemented at year-end 2006. Includes a 5% subjective discount to account for the risks entailed in the reauditing of FNM's financial statements. Assumes that 5% of earnings will go into a special Housing Fund for five years.
Source: Morgan Stanley Research.

Exhibit 2

Freddie Mac: Sensitivity of Price Target to Retained Portfolio Assumptions

FRE - Price Target - New Regime

Growth	Capital Requirement (%)					
(07-09) (%)	2.5	3.0	3.5	4.0	4.5	5.0
10	$97	$94	$90	$87	$83	$79
5	$92	$89	$86	$83	$80	$77
0	$88	$85	$82	$80	$77	$74
-5	$84	$81	$79	$77	$74	$72
-10	$80	$78	$76	$74	$72	$70
:	:	:	:	:	:	:
-40	$68	$68	$67	$66	$66	$65

Base Case

Worst Case

Assumes GSE legislation passed by year-end 2005, new regulatory regime implemented at year-end 2006. Assumes that 5% of earnings will go into a special Housing Fund for five years.
Source: Morgan Stanley Research

Our price targets are based on separate earnings projections and residual income models for the retained portfolio and credit guarantee businesses (see Exhibit 3 and the Appendix for more details). Both target prices include a discount for a proposed housing fund tax equal to 5% of profits for five years. At Fannie Mae, we take out a 5% subjective discount to account for the risks entailed in the reauditing of its financial statements. Risks to the price target would include a major housing market downturn, extreme interest rate volatility, or an unanticipated political outcome, such as legislation eliminating the retained portfolios.

According to our revised target prices, both stocks offer attractive upside. The reduction in our target price at Freddie (from $80 to $77) reflects more conservative assumptions about retained portfolio growth and returns under a new regime. The increase in our target price for Fannie (from $65 to $67) reflects a reappraisal of its credit guarantee business, where we note what appears to be a structurally higher margin than at Freddie. We are now valuing Fannie's credit guarantee portfolio at a price/book multiple of 3.0x, compared to 2.1x for Freddie.

But we favor Freddie over Fannie by a small margin. Once Fannie resumes timely filing of financial statements (in 2006 or perhaps 2007), we forecast the operating net interest margin (exclusive of FAS 133 effects) at 67 bps, compared to a historic range of 90-120 bps. First, the new regulatory regime should require bigger changes to the hedging strategy at Fannie than at Freddie. Since tighter hedging implies thinner margins, the implication is that Fannie's margin will compress toward that of Freddie's. Second, Fannie's margin may also suffer from the volatile interest rates experienced during 2002–3. The economic toll from this period can be seen in the weak relative performance of Fannie's fair value of equity compared to Freddie's. Finally, the new auditor has not yet completed its review of Fannie's books. Some allowance must be made for the possibility of negative adjustments to the company's financial statements, including the all-important fair value of equity disclosure.

Exhibit 3

Price Targets for Fannie Mae and Freddie Mac

Price Target Methodology

	FNM	FRE
Retained Portfolios		
Price/Book (1)	1.3x	1.5x
Book Value (2)	$24.00	$30.00
Current Value	$31.00	$43.50
Credit Portfolios		
Price/Book (3)	2.9x	2.1x
Book Value (2)	$13.10	$14.74
Current Value	$38.00	$30.96
Total Firm		
Price/Book	1.9x	1.7x
Book Value (2)	$37.10	$44.74
Current Value	$69.00	$74.46
5% Housing Fund (4)	-$1.27	-$1.38
Subjective discount (5)	-$3.45	
Adjusted Current Value	$64.28	$73.08
Current Stock Price	$58.76	$65.55
Under/Overvalued	9.4%	11.5%
12-mo Price Target (6)	**$67.00**	**$77.00**

(1) Assumes new regulator raises portfolio capital standard to 4.5% by year-end 2006, with flat portfolio growth thereafter.
(2) Based on OFHEO's most recent release regarding capital adequacy; surplus above minimum allocated equally between Retained and Credit portfolios.
(3) Assumes capital standard remains 0.45% under new regulatory regime, with 6-7% total portfolio growth.
(4) 5% tax on profits 2006-2010.
(5) Equal to 5% of current value for risk that auditor will find that fair value disclosures have been overstated.
(6) Based on 8% cost of capital, less expected dividends. Rounded to the nearest dollar.
Source: Morgan Stanley Research

This report reflects the growing importance of enterprise risk management for financial firms. With Basel II now center stage, regulators are starting to move beyond traditional, plain-vanilla value-at-risk concepts to grapple with broader issues of enterprise risk management. Politicians, too, have become more sensitive to these issues, perhaps because financial risk-taking seems to resonate with the accounting scandals of the stock market crash. We have tried to keep up with changing times, and the analysis in this report represents a major evolution over our previous research.

Please see analyst certification and other important disclosures starting on page 58.

This is the first public study that attempts to quantify the appropriate capital standard for the interest-rate risk associated with MBS. Not only is this question central to the GSE policy conundrum. But also US regulators must figure out interest rate risk before they implement Basel II, which is largely silent on the topic. The main body of this report contains an analysis of the interest-rate risk contained in a GSE-like portfolio of fixed-rate mortgage-backed securities (MBS). To estimate the right capital standards for this portfolio, we built an economic capital framework with solvency standards appropriate for regulated financial entities and examined the performance of this portfolio, together with hedges, in low-probability, extreme interest-rate shock scenarios. To help us with the project, we retained outside experts in risk management (Risk Integrated) and MBS valuation (Applied Financial Technology). We made a point of addressing the concerns of some of the GSEs' most prominent critics about issues like fat-tailed distributions, derivative markets liquidity, basis risk entailed in the use of short-term debt, and model risk.

Exhibit 4

Summary Changes to Key Forecast Variables

Variable	Old Assumption	New Assumption	Rationale
Retained portfolio capital	2.50%	4.50%	
Net interest margin	75 bps at FRE 95 bps at FNM	63 bps at FRE 67 bps at FNM	Regulator imposes additional limits on risk-taking, especially at FNM FNM's margin compresses in relation to the weak performance of its fair value
Retained portfolio growth under new regime	5%	0%	With higher capital, less risk-taking opportunity, GSEs will continue to lose share to aggressive competitors including banks, hedge funds, and foreign investors
Total portfolio growth	11% for FRE 11% for FNM	6% for FRE 5% for FNM	GSEs grow slower than market as they avoid risky new products, retained portfolios no longer growing
G-fees	19 bps for FRE 21 bps for FNM	20 bps for FRE 20.5 bps for FNM	Fannie earns modest premium for higher liquidity
Net Charge Offs / Average Book (bps)	2.0 for FRE 2.0 for FNM	2.5 for FRE 2.5 for FNM	GSEs take on more subprime loans in order to achieve affordable housing goals

Note: FNM NIM includes estimated 9 bps in g-fees for MBS contained in retained portfolio; at FRE, g-fees on PCs contained in retained portfolio are reported in g-fee revenues

Source: Morgan Stanley Research

Exhibit 5

Summary Changes to Earnings Forecast, Price Targets, and Ratings

	Fannie Mae			Freddie Mac	
	Previous	**New**		**Previous**	**New**
Rating	Equal-weight	Equal-weight	**Rating**	Overweight	Overweight
Price Target	$65	$67	**Price Target**	$80	$77
Price Target / 06 EPS		10.7x	**Price Target / 06 EPS**		10.7x
2004 EPS (E)	$6.82	$7.41	**2004 EPS (A)**	$6.49	$3.95
2005 EPS (E)	$7.50	$6.89	**2005 EPS (E)**	$6.93	$7.00
2006 EPS (E)		$6.25	**2006 EPS (E)**		$7.20
2007 EPS (E)		$5.30	**2007 EPS (E)**		$6.89
Earnings CAGR (05-09)		-6%	**Earnings CAGR (05-09)**		0%
EPS CAGR (05-09)		-4%	**EPS CAGR (05-09)**		1%

Source: Morgan Stanley Research. Except for Freddie's 2004 actual, EPS estimates are Operating EPS, which exclude the impact of FAS 133.

Please see analyst certification and other important disclosures starting on page 58.

Eroded Competitive Advantage and Lower Valuation of Retained Portfolios

Under the new regime, the retained portfolios will offer modest returns and little growth potential. Higher capital standards and limitations on risk-taking in the retained portfolio business will come at a time when Fannie and Freddie's competitive advantage has already eroded. In the past, we argued that Fannie and Freddie enjoyed a unique market position, benefiting from a combination of advantages that neither banks nor private investors could match. However, over time, their competitive position appears to have weakened, as their funding cost advantage has narrowed, they have been subject to monthly risk disclosures, and tougher competition may have emerged. Also, Fannie and Freddie have grown quite large, and it should arguably be more difficult today for them to find big enough investment opportunities than when their portfolios were small. Going forward, new capital standards may not only put them on a more level playing field with banks. But also the GSEs may end up subject to a higher degree of regulatory scrutiny than banks, further restricting their latitude for risk-taking relative to the competition. Longer term, we do not know precisely how regulatory guidelines will evolve, but the fact that major banks and broker-dealers are more diversified than the GSEs suggests that ultimately they may enjoy a natural capital advantage. Exhibit 7 below summarizes how we view the GSE's advantages vis-a-vis other MBS investors.

Under our new assumptions, the retained portfolios are worth only a modest premium to book value. To be precise, we value Fannie Mae's retained portfolio business at a premium of 1.2x book value, Freddie Mac's at 1.5x (Exhibit 6). These valuations are a function of assumptions about margins, capital ratios, and growth. With the GSEs' competitive advantage eroded under the new regime, we assume that the retained portfolios will no longer grow.

A skeptic might ask why, if these portfolios are properly capitalized, would these businesses be worth any premium to book value at all? Our response is that, first the companies will continue to enjoy a modest funding cost advantage, reflecting the benefit to debt investors of tougher regulatory scrutiny than is likely to be the case at other financials and thus less risk. Second, the companies will continue to enjoy scale economies, bargaining leverage in dealing with dealers, and the ability to hedge largely without collateral, thanks to their AAA ratings. At Freddie Mac, the margin should contain embedded value from the company's smartly-timed purchases in recent years. At Fannie, we believe the gains from smart purchases have been partially offset by losses suffered during the interest rate shocks of 2002-3. We deduce these losses from the relatively poor performance of Fannie's fair value of common equity (see Exhibit 8 below) and reflect them in a more conservative forecast of the net interest margin going forward (see Exhibit 9 below).

Exhibit 6

Retained Portfolio Valuation as a Function of Capital Requirements and Growth Outlook

FRE - Retained Portfolio FV/B - New Regime

Growth	Capital Requirement (%)					
(07-09) (%)	2.5	3.0	3.5	4.0	4.5	5.0
10	2.08	1.97	1.85	1.74	1.63	1.51
5	1.93	1.83	1.73	1.63	1.54	1.44
0	1.80	1.71	1.63	1.55	1.46	1.38
-5	1.69	1.61	1.54	1.47	1.40	1.32
-10	1.59	1.53	1.47	1.40	1.34	1.28
:	:	:	:	:	:	:
-40	1.25	1.23	1.21	1.19	1.16	1.14

Base Case

Worst Case

FNM - Retained Portfolio FV/B - New Regime

Growth	Capital Requirement (%)					
(07-09) (%)	2.5	3.0	3.5	4.0	4.5	5.0
10	1.89	1.76	1.62	1.48	1.35	1.21
5	1.74	1.62	1.51	1.39	1.28	1.16
0	1.61	1.51	1.42	1.32	1.22	1.13
-5	1.51	1.42	1.34	1.26	1.18	1.10
-10	1.42	1.35	1.28	1.21	1.14	1.08
:	:	:	:	:	:	:
-40	1.14	1.11	1.09	1.07	1.05	1.02

Base Case

Worst Case

Source: Morgan Stanley Research. Assumes preferred stock equal to 20% of capital, operating net interest margin of 0.65% for FRE and 0.65% for FNM, 28% tax rate. See Appendix for segment forecast and valuation models for Fannie Mae and Freddie Mac.

Exhibit 7

Competitive Advantages and Disadvantages for MBS Investors

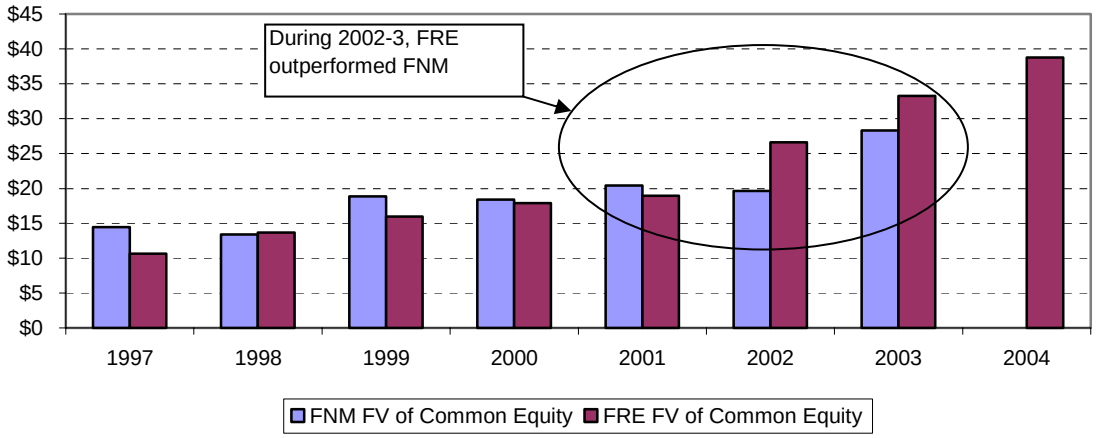
	GSEs		Banks		Other Investors	
Capital requirements	-	Estimated 4-5% standard under new regime makes GSEs less nimble than other investors, closer to level playing field with banks	-	5% tangible leverage standard makes banks less nimble than other investors -- unless bank has substantial excess risk-based capital	+	Capital standards may be quite flexible, depending on broker-dealer margin requirements; hedge fund capital may range from 1 to 5%
Funding costs	+	Unsecured debt now trades at AA level, better than most banks' unsecured debt, but not necessarily cheaper than deposits	+	Raise low-cost deposits, accesses FHLB advances at close to GSE debt costs; banks with high ratings can access low-cost unsecured debt	-	Unsecured debt often not available, limited to secured financing with low cost but mark-to-market requirements
Mark-to-market	+/-	In effect marked to market each month following disclosure of duration gap and other risk metrics; formal fair value balance sheets likely each quarter	+	Not relevant for held-to-maturity portfolios; fair value information on available-for-sale and trading portfolios in call report and quarterly filings	-	Positions may be marked to market by broker-dealers quite frequently, limiting ability to take advantage of market disruptions
Liquidity	+	Common perception of implied guarantee, although could be weakened by new receivership provisions; liquidity also benefit from regulatory scrutiny and "too big to liquidate" doctrine	++	Deposits explicitly guaranteed by government, and in emergency banks may have access to Fed's discount window; debt holders benefit from regulatory scrutiny.	+/-	Liquidity for hedge funds and other leveraged investors might be quite poor in a crisis scenario, especially if broker-dealers are exposed to risk. For other investors, liquidity may depend on flows.
Risk management	+/-	AAA rating limits need to post collateral, creating cash flow advantage. Global market for callable debt. But large size and portfolio concentration poses liquidity risk in option and swap markets	+	Active participants in OTC markets, puttable/convertible advances available from FHLB. Diversification benefits help mitigate risk exposure.	+/-	Active participants in OTC markets; some investors benefit from diversification
Regulatory scrutiny	--	Already tough under OFHEO, likely to be tougher under new regime	-	Scrutiny of interest-rate risk varies by bank		Not subject to supervision

Source: Morgan Stanley Research

Please see analyst certification and other important disclosures starting on page 58.

Exhibit 8

Fannie Mae and Freddie Mac: Fair Value of Common Equity



Source: Company disclosures, Morgan Stanley Research

Exhibit 9

Hypothetical Breakdown of Net Interest Margins (NIM) for Fannie and Freddie

	Old Regime		New Regime	
(in bps)	**FNM**	**FRE**	**FNM**	**FRE**
as % of Retained Portfolio				
OAS on MBS (1)	30	30	10	20
Risk-taking	20	13	10	10
Funding Cost Advantage	15	15	10	10
Spread	65	58	30	40
Float on Equity (2)	13	13	25	25
	78	71	55	65
G-fees on MBS (3)	10	0	10	0
NIM on Retained Portfolio	88	71	65	65
as % of Average Earning Assets				
Retained Portfolio NIM	81	66	53	54
Float on Credit Portfolio	7	5	7	5
Tax Equivalent Effect	7	4	7	4
Tax Equivalent NIM for Entire Firm	**95**	**75**	**67**	**63**

OAS = Option Adjusted Spreads

(1) Assumes benefits of purchases at wide spreads at FNM partially offset by losses from interest rate volatility during 2002-3.

(2) Assumes roughly 5.5% yield on 4.5% equity under new regime, 2.5% equity under old regime.

(3) Freddie Mac margin deducts g-fees from MBS and Participation Certificates held in retained portfolio; these are reported as part of g-fee revenues. Fannie does not net out these g-fees for the purpose of reporting the consolidated net interest margin.

Source: Morgan Stanley Research

In previous research, we had argued that Fannie and Freddie enjoyed competitive advantage in their retained portfolio businesses from several sources:

- *Liquidity.* Like banks, the GSEs benefit not just from low funding costs but also from strong liquidity, giving them a leg up over hedge funds and other market participants without government relationships. Strong liquidity has been crucial to the GSEs' ability to buy large volumes of MBS at attractive spreads during periods of market stress, like the global currency crisis of 1998 or the aftermath of 9/11, when competitors with weaker liquidity were forced to the sidelines.

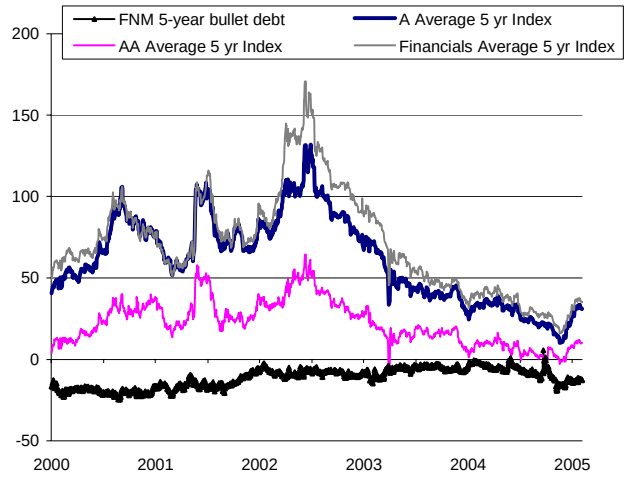
- *Flexible capital standards.* Fannie and Freddie also benefit from low and flexible capital standards, allowing them to manage risk through derivatives, rather than by relying on expensive equity cushions. This feature makes them similar in some ways to hedge funds, whose "haircut" or margin requirements are set by broker dealers based on the risk of the hedge funds' trading positions. In contrast, banks are hamstrung with minimum capital requirements (as in the minimum 5% tangible leverage ratio) which may be appropriate for commercial and industrial loans but which are too high for mortgage investing.[2]

- *Other advantages*. The firms enjoy other significant advantages, including the ability to hedge without having to post collateral with derivatives counterparties[3] and access to a global market of unsecured and callable debt. Further, their large size gives them the economies of scale to afford the best talent and technology and strong leverage in bargaining with broker-dealers.[4] Other benefits include exemption from state and local taxes and from SEC registration requirements for their mortgage-backed and unsecured debt securities.

However, the GSEs' competitive advantage appears to have weakened as their coveted funding cost advantage has narrowed (Exhibit 10). In the past, consistent with their AAA-rating, GSE debt traded at much tighter spreads than financials or even AA-rated issuers. Today, GSE debt trades relatively close to an index of AA-rated securities, and the advantage over financials has narrowed considerably. As the funding advantage has eroded, the growth rate in the GSEs' retained portfolios has become more volatile, suggesting that the firms have had to become significantly more opportunistic in their purchases than was the case in the past (Exhibit 11). The GSE borrowing advantage appears to have narrowed due to political and regulatory criticism, some of which may have weakened debt investors' expectations about the probability of bail-out in a crisis scenario, as well as from revelations about the interest-rate risk inherent in their portfolios. At the same time, other issuers' funding spreads have improved in recent years. Of note, corporate debt spreads have widened in the last couple of months, triggered by the downgrade of Ford and GM's debt ratings. But the widening in corporate spreads does not appear to have affected MBS pricing.

Exhibit 10

GSE Funding Cost Advantage Has Narrowed…



Source: Morgan Stanley Fixed Income Research

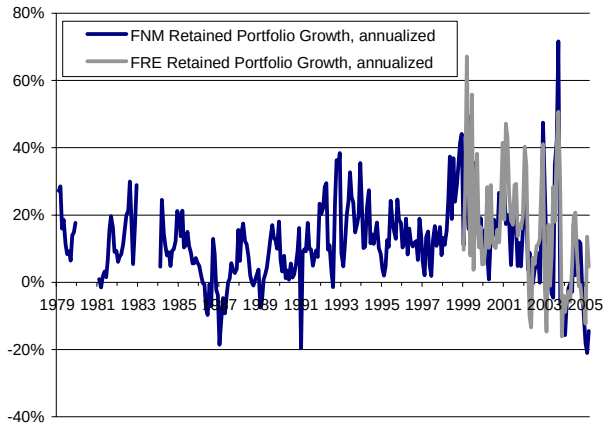
[2] *US Mortgage Finance: The American Dream Industry, 2002-2020*, Morgan Stanley Research, February 5, 2002.

[3] Firms with borrowing constraints may be forced to hedge less than would theoretically be optimal because they may not be able to count on the cash flow to pay for margin calls. Akash Deep, "Optimal dynamic hedging using futures under a borrowing constraint," *BIS Working Papers* No 109, Bank for International Settlements, January 2020. With their AAA ratings, largely unencumbered balance sheets, and the advantage of not having to post collateral, the GSEs may enjoy an important advantage.

[4] Our colleague, Chris Meyer, Morgan Stanley's asset manager/broker-dealer analyst, advises us that large fixed-income investment firms enjoy superior margins because of bargaining leverage. See also James Philpot, Douglas Hearth, James N. Rimbey, Craig T. Schulman, "Active Management, Fund Size, and Bond Mutual Fund Returns," *The Financial Review*, May 1998.

Exhibit 11

And Portfolio Growth Has Become Volatile…



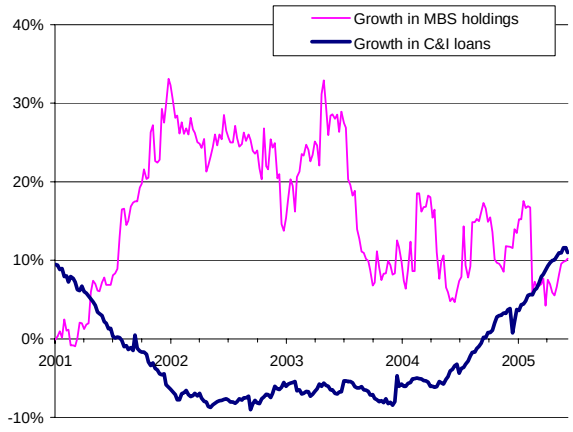
Source: Company data, Morgan Stanley Research

Monthly risk disclosures may have tied their hands. In 2001 Fannie and Freddie agreed to a series of voluntary disclosures to allow market participants to more easily scrutinize their risk profile. These disclosures included duration gap, portfolio market value sensitivity, and other metrics which gave investors insight into the risk management of the retained portfolios. A risk associated with these disclosures would be that market participants may now be better able to anticipate the GSEs' demand for derivatives and perhaps trade opportunistically or "front run" them. It is also possible that, in order to avoid this possibility, the GSEs reduced their level of risk-taking. Either way, monthly risk disclosures represent a disadvantage compared to other MBS investors, who are not forced to disclose their risk positions publicly.

Competition for MBS may also have increased from banks. While banks are subject to the 5% tangible leverage ratio, there may be circumstances when excess risk-based capital or a scarcity of other assets makes MBS an attractive investment for them. In past research, we argued that a resumption in growth in commercial and industrial loans, together with a flattening of the yield curve, would slow the growth in bank MBS holdings.[5] So far in 2005, bank MBS holdings have grown faster than we expected, recently at around 9% year-over-year, despite double-digit increases in commercial loans and major securities portfolio restructurings at several banks (Exhibit 12). The principal reason for this divergence appears to be the purchase activity of a single institution, Bank of America, whose MBS portfolio has expanded to almost $175 billion in recent quarters (Exhibit 13). To put this growth in perspective, Bank of America's portfolio has accounted for some 50-100% of total bank industry net MBS growth in recent quarters. Netting out the growth at Bank of America, banking industry MBS holdings have been growing at around 3% per year. Our colleague Betsy Graseck, Morgan Stanley's large-cap bank analyst, has questioned whether B of A's surprising growth represents an economic strategy or just a tactic for managing GAAP results. Nonetheless, the size of its portfolio suggests that Bank of America has become a major competitor for the GSEs in purchasing MBS. In the future, the same could be true of other big banks.

Exhibit 12

Bank Industry MBS Holdings Are Still Growing Quickly, Despite a Rebound in C&I Loans…



Source: Federal Reserve H.8 release

Exhibit 13

…Largely Due to Fast Growth in MBS Balances at Bank of America

($ Billions)

	3/04	6/04	9/04	12/04
Bank of America Corporation	126.7	155.5	146.7	172.5
Wachovia Corporation	69.7	70.7	69.9	80.0
JPMorgan Chase & Co.	38.9	38.7	49.3	49.6
Wells Fargo & Company	23.4	27.6	25.8	24.3
Citigroup, Inc.	27.5	25.6	21.4	20.7
Fifth Third Bancorp	22.8	22.9	23.3	19.5

Source: SNL

Other investors may have become aggressive buyers of MBS. Our colleagues in fixed-income research point to a growing appetite for MBS on the part of international investors. A recent survey suggests that Asian central banks

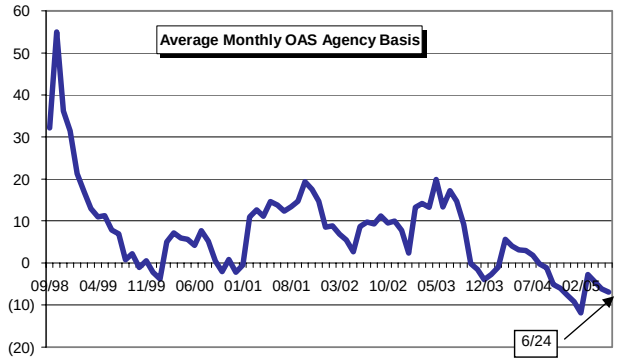
[5] See *Banks, GSEs, and the Yin-Yang of MBS Investment (6/3/2004)*

are allocating more reserves to spread product, including MBS, as yields on US Treasury bonds remain unappealingly low.[6] Also, a recent Federal Reserve study of the market for interest rate options pointed to hedge funds as an important source of liquidity.[7] It is not hard to imagine that hedge funds with a view on the pricing of implied volatility might attempt to arbitrage the MBS market as well, since implied volatility is a key determinant of MBS values.

The popularity of MBS with bank and unregulated investors is apparent in near-record tight spreads on mortgages relative to the GSEs' funding costs (Exhibit 14).

Exhibit 14

Growth Opportunities for Retained Portfolios Continue to Look Poor



OAS = Option Adjusted Spreads. Agency basis = difference between OAS on current coupon MBS and GSE cost of funds.

Source: Morgan Stanley Fixed Income Research

Looking forward, US banks may get away with less scrutiny of their interest-rate risk exposure than the GSEs. Fannie and Freddie's current regulator subjects them to exhaustive reviews of interest rate risk.[8] And we presume that under the new regulatory regime, this scrutiny will only be tougher. Conversations with bank supervisors suggest that regulatory scrutiny of US banks' interest-rate risk is not as tough.

For one, international capital guidelines, as embodied in the new Basel II standard, are largely silent on interest rate risk. The committee discusses policy best practices but leaves the question of capital charges for interest rate risk to individual supervisors.[9] A recent Quantitative Impact Study covering US banks showed that the Basel II rules would result in an average 17% decline in regulatory capital compared to Basel I, driven in part by large reductions in regulatory capital for home equity (down 74% on average) and residential mortgages (down 62%).[10] In our view, these results suggest that banks are not addressing the question of interest rate risk capital in their initial calculations of Basel II capital. If Basel II were implemented in the US without an assessment of interest rate risk capital, reductions in capital standards might make banks more aggressive competitors of Fannie Mae and Freddie Mac[11]. Of course, if the tangible leverage ratio is not dropped, then Basel II's risk-based capital standards might end up moot. As an aside, whether the tangible leverage ratio should be lowered is a controversial point among policymakers. Some regulators argue it must be lowered, otherwise US banks will suffer by being forced to hold more capital than international competitors,[12] although this is by no means the consensus opinion.

Nor have US bank regulators set clear capital standards for interest rate risk. While the Office of Thrift Supervision developed an interest-rate stress test for thrifts, the OCC, Treasury, Federal Reserve, and FDIC elected not to follow suit for banks. Instead of setting rules for interest-rate risk capital charges, the agencies adopted a "risk assessment" approach, under which "capital for interest rate risk is evaluated on a case-by-case basis, considering both quantitative and qualitative factors."[13] In our view, such

[6] "UBS expects sharp increase in Asian support," *Asset Securitization report*, June 27, 2005. An annual survey showed 62% of central bank respondents were planning to add more spread product in the coming year and 45% of respondents on a reserve-weighted basis mentioned MBS and ABS.

[7] Federal Reserve, "Concentration and Risk in the OTC Markets for U.S. Dollar Interest Rate Options," March 2005.

[8] For example, with respect to Fannie Mae, OFHEO's recent assessment included analysis of communication and risk-management front office personnel throughout portfolio strategy, portfolio transactions, treasury, and the risk policy committee. OFHEO plans to conduct a comprehensive review of data inputs, assumptions, methodologies and models, and evaluate middle and back office operations, securities valuation methodologies, and interest-rate risk model development. OFHEO, 2005 Report to Congress, June 15, 2005, p. 17.

[9] Basel Committee on Banking Supervision, *Principles for the Management and Supervision of Interest Rate Risk*, Bank for International Settlements, July 2004, pp. 3, 25.

[10] Testimony of Julie L. Williams, Acting Comptroller of the Currency, before the Subcommittee on Financial Institutions and Consumer Credit of the Committee on Financial Services of the U.S. House of Representatives, May 11, 2005, p. 19.

[11] W. Scott Frame, Lawrence J. White, "Emerging Competition and Risk-Taking Incentives at Fannie Mae and Freddie Mac," Federal Reserve Bank of Atlanta, Working paper 2004-4, February 2004, pp. 17-18.

[12] "Estimating the Capital Impact of Basel II in the United States," FDIC, August 5, 2004.

[13] Department of the Treasury, Office of the Comptroller of the Currency, Federal Reserve System, Federal Deposit Insurance Corporation, "Joint

vague standards likely engender a lack of consistent scrutiny.

Similarly, SEC capital guidelines for broker-dealers do not appear especially tough. The SEC has introduced new capital guidelines for broker-dealers that are fashioned after Basel and rely primarily on the use of historical data to estimate value-at-risk exposures. As we discuss below, the historical approach may be unsuitable for capturing the "fat-tailed" risk of extreme price movements. Further, the SEC's guidelines leave plenty of leeway for firms to ignore supplemental risk factors, like model, liquidity, or basis risk. The SEC believes that the new rules will allow the 11 broker-dealers expected to adopt them to reduce their capital by 40% or $13 billion.[14] While we do not know which parts of these broker-dealers' balance sheets will benefit from reduced capital, it is possible that broker-dealers end up subject to easier capital standards than the GSEs and thus emerge as tougher competitors in the arbitraging of MBS spreads.

Because they are more diversified, banks and broker dealers ought to enjoy a natural capital advantage over the GSEs. Under the theory of economic capital, firms with diversified balance sheets ought to need less capital than firms with concentrated positions. The reason is that some of the volatility in different asset classes, where returns are normally not perfectly correlated with each other, ought to cancel out. Diversification can exist with respect to geographical distribution, asset types, or business functions. The consulting firm Mercer Oliver Wyman estimates that a globally diversified portfolio of commercial credit would require only 55% as much capital as one concentrated in the US. Similarly, the typical bank with credit, operating, and market risk should enjoy a 15% reduction in economic capital compared to what the capital for each of these risks would come to on its own. Finally, Mercer Oliver Wyman sees diversification benefits across banking and insurance functions of around 5-10%.[15]

We can see the benefits of diversification showing up in how banks and broker dealers estimate value-at-risk exposures in their trading portfolios. The major banks and broker-dealers report diversification benefits that reduce their trading book value-at-risk by 25-54% (Exhibit 15). Since Fannie and Freddie's portfolios are limited to a single asset class, with no material foreign currency, equity, corporate credit, or commodity exposure, they would not likely enjoy anything like this level of diversification benefit. Under Basel II and the SEC's new guidelines, capital levels for trading portfolios are set in direct proportion to value-at-risk.

Exhibit 15

Value-at-Risk Diversification Benefits for Major Banks and Broker-Dealers

	Diversification Benefit as % of Value at Risk
Bank of America (1)	54%
Citigroup (2)	51%
Morgan Stanley	43%
Goldman Sachs	38%
JPMorgan Chase & Co. (3)	37%
Lehman Brothers	29%
Bear Stearns	25%

(1) Before effect of credit default swaps used to manage credit risk.

(2) Includes adjustment for specific issuer risks across market risk factors and inter-sector diversification benefit across market, credit, operational, and insurance risk capital.

(3) Includes diversification benefit for trading and credit portfolios.

Source: Company 2004 10-K's, Morgan Stanley Research

Agency Policy Statement: Interest Rate Risk," Federal Register, Vol. 61., No. 124, June 26, 1996, pp. 33166-33172.

[14] Final Rule: Alternative Net Capital Requirements for Broker-Dealers That Are Part of Consolidated Supervised Entities, 17 CFR Parts 200 and 240, Securities and Exchange Commission, August 20, 2004, pp. 15, 19, 54, 74.

[15] "Study on the Risk Profile and Capital Adequacy of Financial Conglomerates," Oliver, Wyman & Company, February 2001, pp. 17-26.

Exhibit 16

Diversification Benefits for Major Banks and Broker-Dealers

Average 2004 One-day Value at Risk ($ millions) (1)

	Bank of America (3)	Bear Stearns	Citigroup (2)	Goldman Sachs	JPMorgan Chase & Co.	Lehman Brothers	Morgan Stanley
Fixed-income	$ 26	$ 15	$ 96	$ 36	$ 74	$ 26	$ 50
Equities	22	5	29	32	28	11	34
Foreign exchange	4	2	16	20	17	4	11
Real estate/mortgage	11	-	-	-	-	-	-
Credit	36	-	-	-	-	-	-
Commodities	7	-	16	20	9	-	33
Subtotal	104	21	157	108	129	41	128
Diversification benefit	(56)	(5)	(65)	(41)	(44)	(12)	(55)
Total Trading VaR	48	16	92	67	85	29	73
Credit portfolio	-	-	-	-	14	-	-
Diversification benefit	-	-	-	-	(9)	-	-
Total VaR	48	16	92	67	91	29	73
Diversification benefit as %	54%	25%	41%	38%	37%	29%	43%

(1) 99% confidence, except for Goldman Sachs at 95%.

(2) Diversification benefit includes specific issuer diversification. Does not include inter-sector diversification benefit.

(3) Does not include effect of credit default swaps used for credit risk management.

Source: Company 2004 10-K's, Morgan Stanley Research

Guarantee Fee Business Still Enjoys a Positive Outlook

Under the new regulatory regime we envision, the GSEs' credit guarantee businesses should still offer excellent returns with moderate growth. We expect the guarantee fee businesses to generate returns on equity in excess of 20% and to grow at around a 7% pace in coming years. We do not anticipate any changes to the current capital standard of 0.45% of on and off-balance sheet assets, nor do we expect a new regulator to mandate changes to their current business practices. The GSEs earn high returns in this business, in our opinion, because the liquidity of the mortgage-backed securities they issue is unmatched. However, under pressure from the growing appetite of capital markets investors to take on residential mortgage credit risk and the rising market power of large banks, and straining to achieve aggressive affordable housing goals set by the Department of Housing and Urban Development (HUD), credit costs will rise somewhat, and returns will fall slightly, we expect.

High returns. We value Fannie's credit guarantee business at 2.9x book value, a notch higher than Freddie's at 2.1x book value. The higher valuation at Fannie reflects what we believe are structurally higher margins (pretax return on assets of 0.17% vs. 0.13% for Freddie), which we attribute to a lower cost structure at Fannie (perhaps due to the larger scale of its business), higher interest income (due to differences in the timing with which the two firms remit cash to investors in their securities), and a slight pricing premium (due to the superior liquidity of its securities). These margins equate to returns on equity well north of 20% (Exhibit 17).

Exhibit 17

Normalized Credit Guarantee Margin Assumptions

(As % of Average Total Portfolio)

	FNM	FRE
Net Interest Income	0.050%	0.015%
Guarantee Fees	0.205%	0.200%
Other Income	0.000%	0.015%
SGA	-0.050%	-0.061%
Loss Provision + REO	-0.033%	-0.033%
Housing Tax Credit Partnerships	0.000%	-0.009%
Pretax Income	0.173%	0.128%
Tax	-0.043%	-0.032%
After-tax Income	0.129%	0.096%
Equity/Assets	0.45%	0.45%
Return on Equity	28.8%	21.3%

SGA = Selling, General and Administrative expenses REO = Real Estate Owned Source: Morgan Stanley Research

Moderate growth. Our forecast of 7% growth in the guaranteed portfolios is slower than the 12-13% CAGR posted over the last five. Partly this is because we anticipate the retained portfolios no longer growing. The retained portfolios could be thought of as the single biggest customers for the credit guarantee businesses.

Capital markets emerging as price-setter for credit risk. Another reason for moderate growth is the cautious attitude of the GSEs toward credit risk. Over the last few years, the GSEs have fallen slightly behind the pace of growth in the total market (Exhibit 18). Their share of new production has fallen even more dramatically, from around 78% in 2000, according to Morgan Stanley Fixed Income Research, to only 54% in the first quarter of 2005. We had previously thought they would gain share. We surmise that Fannie and Freddie's managements do not believe credit risk is properly priced in the current environment, especially with respect to new products like hybrid-ARMs and IOs. They may very well be right on this point. Or they may simply be more conservative than capital markets investors. Because they are regulated entities with valuable franchises, and because their portfolios are not diversified across multiple asset classes, Fannie and Freddie ought logically to be more conservative than the marginal capital market investor with respect to pricing credit risk.

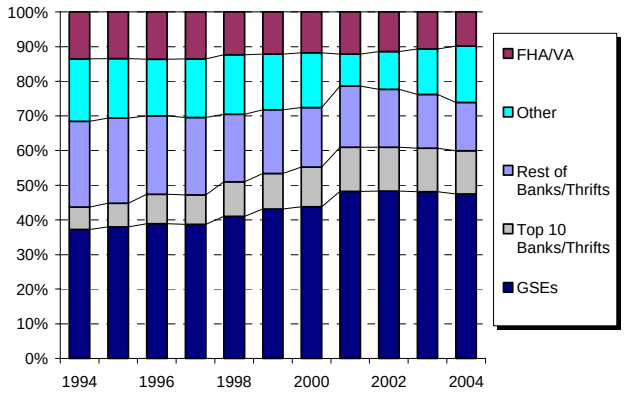
Additionally, while the risk appetite of the capital markets undoubtedly has a cyclical element, there appear to be structural reasons for the growing importance of these markets in intermediating residential mortgage credit risk. In recent years, several trends have added to market liquidity, including the emergence of Collateralized Debt Obligations as a popular structure for holding mortgage and other asset-backed securities (ABS), the development of derivatives for MBS and ABS, growth of securitization in international markets, the spread of hedge funds, and finally the vertical integration of investment banks into mortgage origination and mortgage originators into capital markets trading and distribution. As this market has commoditized, spreads have become tighter,[16] resulting in tougher competition for the GSEs. As such, we now look for Fannie and Freddie's credit portfolios to generate modest growth, not market leading growth.

[16] "Commoditization is the reason this market will continue to tighten," Richard Paddle of HBOS Treasury Services Plc., as quoted in "Spread debate dominates Global ABS Conference in Barcelona," *Asset Securitization report*, Vol. 5, Number 24, June 20, 2005, p. 1.

Exhibit 18

GSE Share of Credit Risk Has Ticked Down

Percentage of Stock of Outstanding Mortgage Debt



Source: Company reports, FDIC, Inside Mortgage Finance, Federal Reserve

Affordable housing goals may be problematic. According to the Mortgage Bankers Association, HUD's new affordable housing goals may be too aggressive, based on unrealistic views of the size of the underserved market.[17] If this is the case, then in order to hit these goals, Fannie and Freddie may have to ration credit to prime borrowers (i.e., reduce their purchases of prime loans). Alternatively, Fannie and Freddie may have to take on more credit risk. According to OFHEO's 2005 annual examination, Freddie Mac has relaxed certain underwriting standards in order to increase market share and achieve affordable housing goals.[18] For this reason, we model the margin between guarantee fees and credit costs compressing by 2 bps over the next five years.

Finally, the growing power of large banks implies pressure on returns. According to *Inside Mortgage Finance*, the top ten sellers of loans to Fannie and Freddie accounted for 64% of their purchases in 2003. As these banks grow in importance to the GSEs, the terms of trade may shift somewhat in the banks' favor. However, since the banks cannot issues MBS with the same liquidity as the GSEs' securities, their ability to negotiate lower g-fees must ultimately be limited.

[17] Mortgage Bankers Association Issue Paper, "GSE Affordable Housing Goals," April 2005.

[18] Examples include the purchase of non-Loan Prospector and No Income/No Asset documentation loans. Freddie Mac management also reported to OFHEO that credit quality and returns may decline in 2005 in its multifamily program due to pressures to meet affordable housing goals. Office of Federal Housing Enterprise Oversight, 2005 Report to Congress, June 15, 2005, p. 22.

Level Playing Field: Assumptions About a New Regulator's Motivations

Our prediction about the decisions that a new regulator will make are based on the economic capital framework discussed below, as well as certain assumptions about the new regulator's motivations, most importantly, the concepts of level playing field and compromise. We envision the regulator remaining tough,[19] but not kow-towing to hardline critics, some of whom had threatened the old regulator with dissolution. Further, with time the agency may become sensitive to a broader range of Congressional constituencies,[20] including the housing lobby, especially if the housing market shows signs of wobbling.

Level playing field. Central to our thinking, we assume that the new regulator views its job as "rehandicapping" the GSEs so that they compete on a level playing field, neither specially advantaged by their charters, nor forced to operate under an arbitrary size limit. The philosophy of US financial regulation has long been that institutions should compete on a level playing field so that competition, rather than the government, dictates which firms grow and which shrink.[21] In this context, we expect the regulator to implement capital standards that are reasonably similar to the US banking industry. Moving to 4-5% as a minimum capital ratio for Fannie and Freddie would be a defensible call, we believe, because it is close to the 5% tangible ratio that limits leverage for US banks. Of note, and as we discuss further below, the regulator will not likely look for guidance to the risk-based capital standards contained in Basel II because these standards do not cover interest-rate risk.

Compromise. For all the technical complexity associated with capital requirements, financial regulations are often the product of compromise.[22] One example of compromise is the implementation of the tangible leverage ratio, requiring banks to hold 5% tangible equity to assets in order to be classified as "well-capitalized." During the early 1990s, regulators were concerned that the new Basel I risk-based standards would allow small banks to reduce their capital ratios at a time when risk in the economy was perceived to be high. Then-FDIC chairman Bill Seidman argued for the leverage ratio because Basel I did not include a capital charge for interest rate risk. The tangible leverage ratio was the result of a compromise between the FDIC and the OCC.[23] Today's controversy over the potential for a sizeable decline in capital ratios under Basel II echoes these early 1990s concerns.

Because of the technical complexity of interest-rate risk management models, the new regulator will need to follow a common-sense approach to setting capital standards. The economic capital calculations contained in the body of this report represent our best judgment on the subject, but other approaches and a wide range of outcomes are possible. For example, as we discuss below, a study of Fannie Mae by R. Glenn Hubbard concluded that the firm's risk profile under current capital standards is as low as, or lower than, that of large bank holding companies. Even more extreme, the present risk-based stress test model employed by OFHEO appears to require zero capital for hedged MBS. On the other hand, also discussed below, using a conventional value-at-risk approach based on Freddie Mac's monthly risk disclosures might imply a capital standard as high as 13%. Alternatively, the Basel II guidance for regulators on interest rate risk, which suggests that a 200-bp rate shock should not erase more than 20% of an institution's capital, would imply a 20% capital standard for the GSEs' retained portfolios.[24] Undoubtedly the new regulator will study a number of technical models. It will certainly have to justify its ultimate decision to Congress and the financial regulatory community, but it will probably not have to divulge publicly which model it put the most weight on.

[19] The scars associated with the accounting scandal and management shake-up at Freddie Mac in 2003, which caught OFHEO by surprise and embarrassed it, likely run deep. OFHEO Deputy Director Steven Blumenthal characterized the "Freddie Mac failure" as "a humiliating experience for OFHEO…we were asleep at the switch." U.S. Department of Housing and Urban Development Office of Inspector General, Special Investigation Division, Investigation Number SID-04-0034-I, "Armando Falcon, Jr., Director, Office of Federal Housing Enterprise Oversight," October 5, 2004, pp. 8, 11.

[20] "No bureau can survive unless it is continually able to demonstrate that its services are worthwhile to some group with influence over sufficient resources to keep it alive." Anthony Downs, *Inside Bureaucracy*, 1967, p. 7. Congress often struggles to control independent agencies. James Q. Wilson, *Bureaucracy*, 1989, p. 250.

[21] Helen A. Garten, *US Financial Regulation and the Level Playing Field*, 2001, pp. 56-57, 117.

[22] Zuhayr Mikdashi, *Regulating the Financial Sector in the Era of Globalization: Perspectives from Political Economy and Management*, 2003, p. 50.

[23] L. William Seidman, *Full Faith and Credit: The Great S&L Debacle and Other Washington Sagas*, 1993, pp. 133-134.

[24] In our analysis, a 200-bp shock could erase as much as 5% of capital, even before considering supplemental risk factors like model, basis, and liquidity risk. We assume that retained portfolio capital is 80% of the total firm's capital, so 20% = 5%/.2*.8.

Capital for the Retained Portfolio: A Multi-factor Economic Capital Model

The heart of this report is an economic capital model for MBS. To estimate capital levels, we simulated the performance of GSE-like portfolios of fixed-rate MBS across a large number of low-probability, extreme interest rate shock scenarios, using a random interest rate path generator developed by Morgan Stanley's risk management department to measure value-at-risk for client trading positions. We benefited from assistance from Applied Financial Technology, which valued MBS and derivative securities across these scenarios, and Risk Integrated, which helped us develop an economic capital model appropriate for a range of target debt ratings (see sidebar). Thanks to this expert assistance, the analysis in this study represents a major evolution over our first effort to gauge GSE capital adequacy, contained in a 2002 report entitled *Fannie Mae, Freddie Mac, and Interest Rate Risk* (see Exhibit 2-2). Even so, our analysis will likely strike true experts in MBS risk management as simple and imperfect. For example, we considered only the most basic duration and convexity hedges, rather than exploring a range of hedging strategies. Also, we measured only the fundamental risk from interest rate shifts that would affect the cash flows for a hold-to-maturity investor; we did not allow for fluctuations in spreads that might affect mark-to-market values. Thus this analysis would not be appropriate for a trading portfolio. Other caveats are mentioned throughout the report.

However, as imperfect as the analysis may be, it is the first public study we know of that tries to quantify capital standards for MBS interest rate risk. As such, we hope our estimates are useful both to investors and to policymakers. We expect to see economists and regulators focus more attention on this topic, given its importance to the GSEs, the banking industry, and the implementation of Basel II in the US.

Also unique to our approach is an examination of special risk factors highlighted by GSE critics. We take a stab at measuring basis risk, i.e., the practice of using short-term debt to fund long-term MBS, a risk pointed out by St. Louis Fed President Bill Poole. During an interest-rate shock, a financial institution with basis risk might suffer from widening spreads on its short-term debt, if capital markets investors became concerned over its risk profile. The resulting margin pressure would compound whatever loss had been suffered in the shock itself. Additionally, we estimate the possible economic cost to rebalancing a portfolio during a period when the swap market is illiquid, a risk that Fed Chairman Alan Greenspan has highlighted. These risk factors fall outside the realm of traditional economic capital calculations, of the sort that are contained in the new Basel regulations, but are entirely valid risk management issues, especially for institutions with large, concentrated MBS positions.

Applied Financial Technology provides quantitative risk analytics to the mortgage industry. The AFT library provides prepayment models for fixed, adjustable, prime and sub-prime mortgages, home equity loans, home equity lines of credit, manufactured housing and others. AFT provides a complete set of prepayment modeling and historical performance analysis tools for customized applications and can create tailor-made prepayment models to fit client data. See www.aftgo.com for more information.

Risk Integrated Dr. Chris Marrison is the author of *The Fundamentals of Risk Measurement* and the CEO of Risk Integrated. Risk Integrated develops methodology and technology solutions for risk measurement, with a focus on real estate and project finance. Further information can be found at www.RiskIntegrated.com.

The analysis, conclusions, and recommendations contained in this report reflect the views of Morgan Stanley Research, not those of Applied Financial Technology or Risk Integrated.

Morgan Stanley's ModelWare group sponsored this study as part of an ongoing project to develop economic models that serve as inputs to financial statement projections.

Exhibit 19

How Our Analysis of MBS Interest Rate Risk Has Evolved Over the Last Three Years

Factor	*Fannie, Freddie, and Interest Rate Risk (9/02)*	*Fannie, Freddie, and the Road to Redemption (7/05)*	Comments
Interest rate distribution	Normal distribution	GARCH (1,1) model used by Morgan Stanley risk management	To capture "fat tails"
Portfolio composition	Single MBS	Portfolio consistent with current distribution of coupons	Better representation of GSE portfolio
Interest rate shock scenarios	60 parallel shock scenarios; yield curve not addressed	50,000 interest rate scenarios incorporating parallel and yield curve shocks; 200 scenarios fully valued	More granular analysis
Security valuation	Bloomberg	Applied Financial Technology	Best-in-class valuation
Capital framework	Probability-weighted losses	Value-at-risk stress scenarios	Used economic capital definition
Target debt rating	Approximately investment grade	AAA, AA/A, BBB, BB	Probabilities benchmarked to Moody's
Model, basis, liquidity risk	Not addressed	Explicitly modeled	
Ongoing growth	Gave credit to likely growth opportunities in spread-widening shock scenario	Does not give credit	Not a risk management best practice to assume growth will offset losses
Conclusion	GSE retained portfolio interest-rate risk approximately investment grade at 4.0% equity/assets	Under traditional interest rate risk capital definition, AA/A standard requires 1.2-3.2%	Credit, operational, liquidity, basis, and model risk require addiitional capital

Source: Morgan Stanley Research

Please see analyst certification and other important disclosures starting on page 58.

Theory Points to a 4.5-7% Capital Ratio for the Retained Portfolio

Our calculations lead to a theoretical capital ratio for a GSE-like retained portfolio of fixed-rate MBS of 4.5–7%. As noted above, we predict that a new regulator will compromise at a ratio 4-5% plus limitations on certain forms of risk-taking. Exhibit 20 shows how we arrive at the 4.5–7% range, as a function of adding up capital requirements for different components of risk, as well as by crediting reductions in capital for the use of hedges to mitigate risk. The following sections of this report take the reader step-by-step through each component of risk. The analysis holds the GSEs to a AA/A debt rating standard, appropriate for a financial institution. Implicit in this range is the assumption of a strict hedging policy, whereby the duration gap is kept to zero months and 75% of convexity and vega risk are hedged.

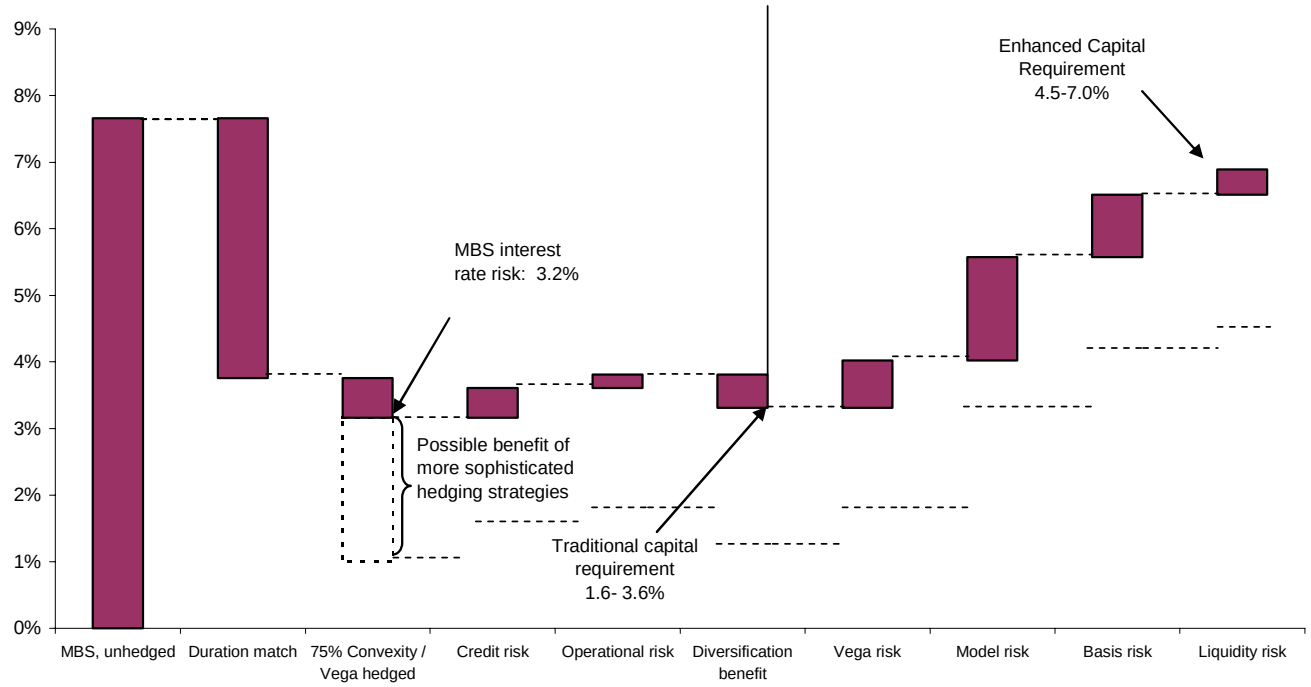
For regulated financial institutions with different hedging policies than the GSEs, our model suggests that capital could range from as low as 1.6% to well over 8%. The right number within this wide range depends on the degree to which institutions hedge the risk, on how much they rely on short-term debt to fund the MBS, and on whether their portfolios are so large as to raise questions of liquidity risk. The lower end of the range would apply to a firm that fully hedged interest rate risk. But even with no exposure to interest rate risk, a small cushion of capital is needed to protect against "model risk," i.e., the risk of loss associated with the imprecision of MBS valuation models, which depend on predictions of consumer prepayment behavior that can never be perfect. The upper end of the range would be appropriate for a firm that funded MBS with short-term debt and did not hedge at all.

Admittedly, our calculations are imperfect. Presumably, under our framework, the management of the GSEs could argue for a somewhat lower ratio, by structuring duration and convexity hedges in a more efficient manner, or by purchasing MBS with less risky characteristics than what we assumed comprise their portfolios. On the other hand, we could have been more conservative in our estimates of basis risk, and our analysis may miss other risk factors associated with large and complex portfolios.

Our capital estimates are substantially higher than current standards for several reasons. First, we note that standards for AA or A-rated issuers are much higher than for other investment-grade ratings. The probability of default for AA-rated financial institution should be no higher than 0.06% per year. Put differently, a AA-rated institution should have enough capital to withstand enormous shocks thought to occur with extremely rare frequency.

Exhibit 20

How We Get to 7% — Allocation of Capital Requirement by Risk



Note: We assume that vega, model, basis, and liquidity risk are correlated with MBS interest rate risk. Source: Morgan Stanley Research

Second, our analysis considers the reality that interest rate changes have "fatter tails" than normal distributions would suggest. Finally, we explicitly considered risk factors such as model, basis, and liquidity risk, that are sometimes ignored in calculations, but which seem appropriate for the GSEs given their large and concentrated portfolios. Regulatory guidelines encourage managers and supervisors to analyze these risks, but do not mandate specific formulae for calculating capital cushions, and for some financial institutions these kinds of risk may be overlooked. But for the GSEs, so intense is the present scrutiny of their operations, a new regulator will not likely ignore them, in our view.

For some perspective on how we end up with a 7% capital ratio (the upper end of our GSE range), 3.8% represents the basic standard for interest-rate, credit, and operational risk, offset by diversification benefits — the traditional regulatory definition. As part of these calculations, we retained the current capital standard for credit risk, namely 0.45% of assets,[25] and made conventional assumptions in regards to operating risk, and diversification benefits.[26] The other 3.7% in the capital ratio acts as a supplemental cushion against vega, model, basis, and liquidity risk, of which the largest component is model risk (Exhibit 20).

[25] We assume that the current regulatory standard of 45 bps remains appropriate for the credit risk associated with mortgage-backed securities backed by prime residential mortgages supplemented by private mortgage insurance. This assumption is at the low end of current practitioners' estimates for new mortgages; however, the GSEs' existing mortgages benefit from very low loan-to-value ratios. Paul S. Calem, James R. Follain, "The Asset-Correlation Parameter in Basel II for Mortgages on Single-Family Residences," Board of Governors of the Federal Reserve System, November 6, 2003. Paul S. Calem, Michael LaCour-Little, "Risk-based capital requirements for mortgage loans," *Journal of Banking & Finance*, 2004. "Retail Credit Economic Capital Estimation -- Best Practices," Risk Management Association, February 2003.

[26] We assumed that credit, interest rate, and operating risk were uncorrelated. Thus the total capital ratio is equal to the square root of the squares of credit risk capital, operating risk capital, and interest rate risk capital. If these risk are positively correlated, then our total capital estimate would be too low.

Economic Capital Framework

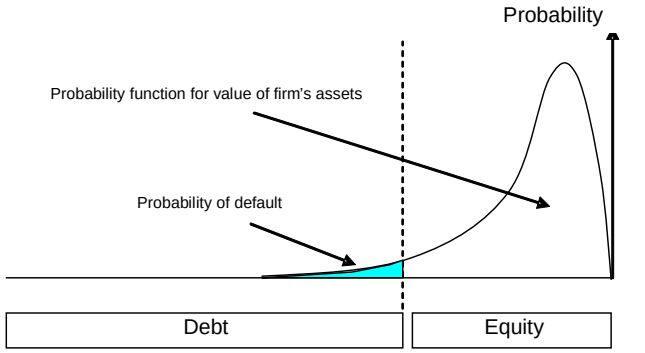
We derive our capital estimates using an "economic capital" framework. The following definition comes from *Risk Measurement* by Chris Marrison of Risk Integrated:

> Economic capital is the net value the bank must have at the beginning of the year to ensure that there is only a small probability of defaulting within that year. The *net value* is the value of the assets minus liabilities. The *small probability* is the probability that corresponds to the bank's target credit rating.[27]

The concept of economic capital is illustrated graphically in Exhibit 21, which shows how the value of a firm's assets can be thought of as a probability distribution. In our analysis, we used an interest rate model to generate a wide range of random interest rate shocks, against which we then valued a portfolio of MBS and hedges: this provided us with a probability distribution for a GSE-like portfolio of assets. In each scenario, the magnitude of economic loss to the portfolio (if any) tells us how big of a capital cushion we would need for the firm to avoid defaulting on its debt. We used small probabilities appropriate for different target debt ratings by referring to Moody's historical default rates. Implicit in this definition is the idea that assets and liabilities should be valued at market, not at historical cost.[28]

Exhibit 21

Graphical Representation of Economic Capital



Source: Based on Marrison, pp. 15-16.

Targeting A to AA debt ratings. Our economic capital analysis starts with the assumption that Fannie and Freddie should target a stand-alone debt rating between A and AA, roughly consistent with the standards embodied in the Basel capital formulae. While the companies' debt is rated AAA, this is partly because the rating agencies give them explicit credit for "strong government-implied support" and a "central role in US housing finance policy," among other factors.[29] On a stand-alone basis, the rating agencies regard them as approximately AA-. Fitch believes that for finance companies, the A level rating "achieves the best combination of long-term viability, cost-effective access to long- and short-term funding alternatives and optimal long-term return to shareholders."[30] In this study, we lump AA and A together because the difference in historical default rates, according to Moody's, is very small.

A/AA is a high standard: A/AA-rated firms rarely default. To estimate the probability of default associated with these rating levels, we turn to historical data from Moody's, which shows that over the last 84 years, annual default rates for A and AA-rated firms have averaged around 6-8 bps (Exhibit 22).[31] What this means for economic capital is that we need to model shocks so

[27] Chris Marrison, *The Fundamentals of Risk Measurement*, 2002, p. 16.
[28] Equity investors should note that economic capital measures value in the same way as fair-market or mark-to-market values of equity. In all cases, these measures can be thought of as the present value of future net interest income over the life of the portfolio. E. Mays, "NII and NPV Simulation: Are the Two Methods for Measuring IRR Consistent?", *Risk Management Series*, Office of Thrift Supervision Risk Management Division, August 1995. As an aside, we have argued and continue to believe that fair value of equity is the best representation of "book value" and simplest valuation metric, because it cuts through accounting distortions caused by FAS 115 and FAS 133. See "Wouldn't You Rather Pay for Transparency," *Morgan Stanley Research*, January 7, 2003. We also find the metric useful in judging the capital adequacy of Sallie Mae. See "Raising Price Target to $46, But Remain Underweight," March 30, 2005. For an explanation of how FAS 115 and FAS 133 can distort GAAP book value, see "The Mystery of the Disappearing Equity," November 22, 2002.

[29] Brian Harris et al, "Moody's Outlook for Fannie Mae, Special Comment," Moody's Investors Service, October 2004, p. 1.
[30] John S. Olert, et. al., "Finance Company Capital Standards — 2004," *FitchRatings*, April 15, 2004, p. 5.
[31] *Default and Recovery Rates of Corporate Bond Issuers, 1920-2004*, Moody's Investors Service, January 2005, p. 16, Exhibit 17. We use the year one default rate, reasoning that later years include firms that have migrated to lower ratings.

extreme as to have a probability of occurrence of only 6-8 bps per year. The required level of capital for the GSEs, then, is whatever it takes to absorb that level of extreme shock without failing.[32] For some perspective, if we thought Fannie and Freddie only needed to be BBB (or just barely investment grade), then our capital estimate, based on an annual default probability of 31 bps, would have come to only 5.3%. Conversely, to achieve a true AAA risk profile, the capital level would need to be 8.8%.

Exhibit 22

Retained Portfolio Capital Standards for Different Target Debt Ratings

	Approximate Rating			
	AAA	AA/A	BBB	BB
Annual default rate (bps)	2.5	6	31	139
Implied monthly default rate (bps)	0.2	0.5	2.6	11.6
Scenario (of 50,000)	1	3	13	58
Traditional				
MBS portfolio, st debt funded	8.1%	7.7%	6.2%	4.9%
Duration matched funding	5.4%	3.8%	3.0%	2.2%
75% convexity hedged	4.4%	3.2%	2.3%	1.2%
+ Credit risk	0.5%	0.5%	0.5%	0.5%
+ Operational risk	0.2%	0.2%	0.2%	0.2%
+ Diversification Benefit	-0.5%	-0.5%	-0.5%	-0.5%
Traditional regulatory capital definition	4.6%	3.3%	2.5%	1.4%
Supplemental risk factors				
+ Vega risk	0.7%	0.7%	0.6%	0.6%
+ Model risk	2.0%	1.6%	1.0%	0.9%
+ Basis risk, 40% st debt	1.0%	0.9%	0.8%	0.7%
+ Swap market liquidity	0.4%	0.4%	0.3%	0.2%
Total capital requirement	8.8%	6.9%	5.3%	3.8%

st = short term
Source: Moody's default history, 1920-2004, Exhibit 17, p. 16, Morgan Stanley Research

As an aside, the economic capital framework is part of a broad literature discussing the optimal capital ratio. The basic goal in choosing a debt-equity ratio is to balance the benefit of debt financing, i.e., its low cost and tax deductibility, against the loss of financial flexibility and the risk of distress that comes from excessive leverage.[33] For regulated financial firms, there is a social dimension: regulators must weight the benefits to the economy of efficient intermediation of credit against the systemic risk associated with bank failure.[34]

Incentives also matter. In a noted article, Harvard professor Michael Jensen argued that the right mix of equity and debt also helps balance the agency incentives of owner operators. At regulated financial institutions, Jensen argued that debt investors are comfortable with high leverage because they benefit from the monitoring actions of regulators, whose risk-averse incentives are compatible with debt holders' interests, but who obtain non-public information and have enforcement powers not available to investors. Regulators can also constrain managements from taking on risky projects or diversifying into unrelated businesses. The power of regulators makes debt holders comfortable with a lower equity cushion.[35] Additionally, economists have made the argument that a large proportion of debt in the capital structure of financial institutions makes sense because their assets consist largely of debt (i.e., loans). The monitoring efforts of debt holders may reinforce the incentive for managements to closely monitor the creditworthiness of their borrowers.[36]

Finally, one can argue that companies should hold extra capital if their markets offer opportunities for investment and growth. Conversely, for firms in mature industries, investors may prefer higher leverage, because they do not want management teams spending cash on negative present value projects.[37] For financial firms, however, regulatory standards set a floor on the equity cushion.

Time horizon

Our analysis is built around a one-month time horizon for extreme interest rate shocks. We settled on one month as a compromise between full-year and daily time frames. Theoretically, the choice of the analysis horizon should not affect the answer. More ambitious studies might look at

[32] As we discuss below, we conducted the interest rate risk analysis using a shock horizon of one month. As such, we use monthly probabilities derived from the annual standard by dividing by 12. This calculation assumes that the risk of an extreme shock is independent from month to month and that losses do not accumulate from month to month. The calculated capital is the amount that should be held to protect against an extreme event that could wipe out the bank within a month. In reality, slightly more capital should be held to guard against the additional risk of the bank being wiped out by the accumulation of less extreme losses over several months.

[33] Anil Shivdasani, Marc Zenner, "How To Choose a Capital Structure: Navigating the Debt-Equity Decision," *Journal of Applied Corporate Finance*, Volume 17, Number 1, Winter 2005.

[34] Anthony M. Santomero, Ronald D. Watson, "Determining an Optimal Capital Standard for the Banking Industry," *The Journal of Finance*, Vol. XXXII, No. 4, September 1977, p. 1279.

[35] Michael C. Jensen, William H. Meckling, "Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure," *Journal of Financial Economics* 3, no. 4, October 1976.

[36] Theoretical models of the cost of delegated monitoring predict that financial firms will operate with high levels of leverage. "There is a strong similarity between the incentive problem between an individual borrower and lender and that between an intermediary and its depositors." Douglas W. Diamond, "Financial Intermdiation and Delegated Monitoring," *Review of Economic Studies*, 1984, p 393.

[37] "Morgan Stanley Roundtable on Capital Structure and Payout Policy," *Journal of Applied Corporate Finance*, Volume 17, Number 1, Winter 2005.

different time horizons to see how the answers change in practice.

Arguing in favor of a one-year horizon is the common practice of discussing annual default frequencies associated with target debt ratings. On the other hand, it would be odd to suggest that during the course of a full year, when an extreme interest rate shock was presumably manifesting itself through a series of smaller shocks, that the management of the GSEs would not rebalance their portfolios or take other actions to mitigate the full force of the shock. Freddie Mac uses an economic capital model which operates over a one-year horizon and assumes that the portfolio is rebalanced during this period so as to remain in compliance with the company's duration and convexity risk limits. However, as we discuss below, it is questionable whether regulators will credit assumptions about management actions in assessing minimum capital standards. Thus the one-year horizon seems problematic.

Another alternative would have been to use the one-day standards that are common for calculating value-at-risk. However, in this case, we would have to extrapolate from a maximum one-day loss to a full-year loss. The standard convention for this is to multiply by the square root of 250 trading days in a year. Given the non-linear properties associated with interest rate volatility and MBS valuation, we thought it better to base the capital requirements on actual losses, rather than scaling from daily or monthly to annual loss figures. Also, for some of the supplemental risk factors, it would be difficult, at least conceptually, to measure these risks on a one-day basis. For example, how illiquid could the swap market become in a single day? How much model risk could result from a single day's interest rate movements?

As an example of the problem with a daily value-at-risk framework, Freddie Mac's PMVS disclosures could be taken to imply a capital standard of approximately 13%, which we view as unreasonably high. Each month Freddie discloses its "portfolio market value sensitivity" or PMVS to level rate shocks and yield curve shifts. Over the last year, PMVS-50 has averaged around 2.0%, meaning that Freddie estimates an immediate, parallel shift in interest rates up or down by 50 bps would cause an economic loss of approximately 2% of its net portfolio value. We know from Freddie's disclosures that it views a 50-bps parallel shock as having a 5% probability during any given month.[38] As such, the PMVS-50 can be thought of as equivalent to a 95% one-month value-at risk, or a measure of the worst expected loss that would be incurred with a 95% probability in a month. We can extrapolate from a 95% one-month value-at-risk to a regulatory capital standard by transforming the statistic to a 99.9% one-year figure. To convert the probability from 95% to 99.9% requires multiplying by 1.88. To convert the statistic from monthly to annual requires multiplying by the square root of 12. The result is a capital standard of 13%. This figure strikes us as unrealistically high, illustrating the problem in extrapolating capital standards from short-term risk measures.

For these reasons, the one-month horizon seemed like a reasonable compromise.

Regulators, Rating Agencies, and Banks Have Adopted Economic Capital as a Best Practice for Risk Management

Regulators favor economic capital models for measuring interest rate risk. The Basel Committee on Banking Supervision prefers economic capital models because they capture the potential impact of interest rate changes on the present value of all future cash flows. In contrast, the committee warns against measuring earnings sensitivity to interest rates, because the focus may be too short-term.[39] The Office of the Controller of the Currency (OCC), the US national bank regulator, agrees.[40]

Modern financial institutions are moving slowly but surely toward economic capital frameworks. A 2001 study by consultants Mercer Oliver Wyman found that most of the major Dutch financial conglomerates were adopting economic capital as the fundamental measure of risk within their institutions.[41] Basel conducted a study in 2003 encompassing 31 financial institutions in 12 jurisdictions. Results were mixed. The committee found a growing focus on firmwide risk management based on aggregating risks with the help of mathematical models. However, "it is clear that risk aggregation and economic capital methods are still

[38] Freddie Mac, 2001 Annual Report, p. 41. As an aside, this probability seems consistent with a HJM-type interest rate model based on a normal or lognormal distribution. We argue below that these models are not appropriate for risk management purposes because they do not consider the possibility of "fat tails."

[39] Basel Committee on Banking Supervision, *Principles for the Management and Supervision of Interest Rate Risk*, Bank for International Settlements, July 2004, p. 7.

[40] OCC Bulletin 2004-29, Subject: Embedded Options and Long-Term Interest Rate Risk, Comptroller of the Currency Administrator of National Banks, July 1, 2004, p. 4.

[41] "Study on the Risk Profile and Capital Adequacy of Financial Conglomerates," Oliver, Wyman & Company, February 2001, p. 28.

in early stages of evolution," the committee reported, with some firms remaining skeptical, especially those whose business is concentrated in a single asset type.[42] Even so, today virtually all major US banks use economic capital models for risk management and investment decisions, according to Morgan Stanley's large-cap bank analyst, Betsy Graseck. US broker dealers, now subject to SEC capital guidelines fashioned after Basel standards, are in various stages of implementing economic capital models, according to Morgan Stanley's broker/asset-management analyst, Chris Meyer. Major European banks have adopted economic capital models, according to Morgan Stanley's global bank team leader, Davide Serra.

After years of swimming apart from the mainstream, the GSEs are developing economic capital models, too. Under their GSE charters, Fannie and Freddie have been subject to special capital standards, including not only statutory ratios, but also risk-based capital stress tests, which, while similar in spirit to economic capital, involve a unique and highly complex computer simulation methodology. A risk management study by the rating agency Moody's reports that both Fannie and Freddie have "started to develop approaches to economic capital for their businesses with a view to measuring capital adequacy." Moody's hopes the firms will complete these models and integrate them with the strategic risk management function on an "accelerated basis."[43] Freddie Mac told us that it has employed an economic capital model since the mid-1990s to allocate capital for interest-rate risk; it uses this model in making MBS purchase decisions. Fannie Mae declined to discuss its risk management models with us.

In our view, the GSEs must develop economic capital models, because the risk-based capital standard under which they currently operate appears too easy. For example, we note that the current risk-based capital model appears to require zero capital for a mortgage-backed security which has "significant convexity coverage," even if the duration gap associated with the mortgage-backed security varies as widely as +/- 6 months, according to Freddie Mac investor relations materials.[44] Zero capital cannot be the right answer.

[42] Basel Committee on Banking Supervision, "Trends in risk integration and aggregation," Bank for International Settlements, August 2003.
[43] Herve Geny, Brian Harris, John J. Kriz, "Industry Analysis: The Housing Government-Sponsored Enterprises (GSEs), Risk Management Assessment," Moody's Investors Service, December 2004, p. 14.
[44] This estimate is based on the OFHEO risk-based capital simulation model for a par coupon 30-year fixed-rate mortgage loan as of 4/8/2003, as executed by Freddie Mac. "Investing in the U.S. Housing Market," Freddie Mac, September 24, 2004, p. 40.

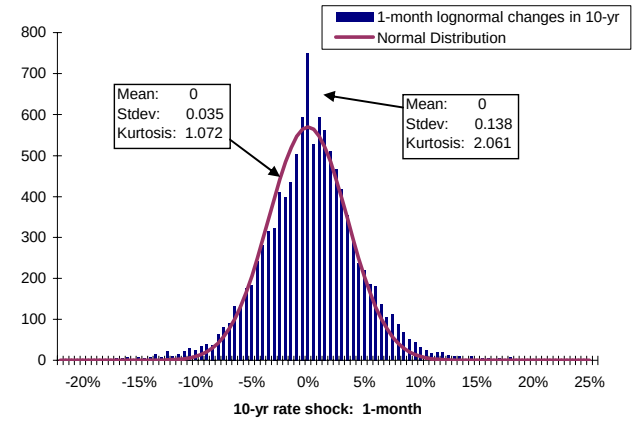
Interest Rate Volatility and "Fat Tails"

Critics' concerns over GSE capital adequacy have tended to center on interest rate risk. Because of the high quality of loans in the GSEs' portfolios, the portfolios' nationwide diversification, liberal use of private mortgage insurance, and the propensity of consumers to stay current on mortgages to protect their homes, credit-related risk has not been a major problem for Fannie or Freddie in recent memory. And this despite serious regional downturns in the 1980s (rustbelt and oil-patch) and the 1990s (Califonia and New England). But interest rate risk is harder to measure and model, especially for mortgage-backed securities, whose values are determined by "black-box models" sensitive to assumptions about prepayment speeds. Also, the interest rate volatility of the late 1970s and early 1980s not only led to the S&L crisis, involving the failure of thousands of thrifts at a cost to taxpayers of hundreds of billions of dollars, but also imperiled Fannie Mae's solvency.[45] So precedent, as well as imagination, makes interest rates the more feared risk factor.

Fat tails. One of the biggest worries about interest rates is that unexpectedly large shocks might lurk just over the horizon. Benoit Mandelbrot, the inventor of fractal geometry and one of the pioneers of chaos theory, recognized that the volatility of prices in financial markets may itself be unstable. Shifts in volatility lead to a distribution of price changes with fatter tails, i.e., a higher proportion of extreme price changes, than the normal bell curve would predict. Markets seem to go through periods of intense volatility, he noted, and then periods of relative calm. Without recognizing this pattern, one might underestimate the probability of major shocks.[46] This is clearly the case for interest rates, where history shows that the tails are visibly fatter than the normal bell curve (mathematically, this is captured in a "kurtosis" statistic for the historical distribution that is double that of a normal curve fitted to the data -- Exhibit 23). In a recent speech, St. Louis Fed president Bill Poole argued that failure to take adequate account of fat tails has been responsible for many failures of financial firms over the years, such as the 1998 collapse of Long Term Capital Management. In this regard, he warned that Fannie and Freddie's hedging strategies "raise warning flags."[47]

Exhibit 23

Historical Interest Rate Changes Have Fatter Tails Than the Normal Distribution Would Suggest



Historical distribution of month-to-month changes calculated on a lognormal basis over period 1953-2005.

Source: Morgan Stanley Research

Our analysis is based on an interest rate model from Morgan Stanley's risk management department. This model is specified as a GARCH (1,1) model, meaning that it allows for interest rate volatility to shift randomly, in the spirit of Mandelbrot's observations about fat tails.[48] Morgan Stanley's risk management department uses this GARCH model to estimate value-at-risk for client positions and set margin requirements accordingly.

To gauge how much capital Fannie and Freddie (or other financial institutions) should hold against MBS, we used the GARCH model to generate 50,000 random yield curve scenarios over a one-month time horizon. The idea was to see what might happen to a portfolio of MBS in the face of extreme rate shocks. The portfolio contained a mix of MBS with different coupons in proportion to the current

[45] According to HUD, the market value of Fannie's equity plunged to negative $10.8 billion in 1981, before recovering to $907 million in 1985. *1986 Report to Congress on the Federal National Mortgage Association*, Office of Policy Development and Research, US Department of Housing and Urban Development, June 29, 1987, p. 100.

[46] Benoit Mandelbrot, Richard L. Hudson, *The (Mis)Behavior of Markets: A Fractal View of Risk, Ruin, and Reward*, 2004, pp. 97, 168-172, 271-4.

[47] William Poole, President, Federal Reserve Bank of St. Louis, "GSE Risks," St. Louis Society of Financial Analysts, St. Louis, Mo, Jan 13, 2005. Other regulators understand the concept of fat-tailed risk resulting from complex interactions between policies, institutions, instruments, and markets. Zuhayr Mikadashi, *Regulating the Financial Sector in the Era of Globalization*, 2003, p. xxiv.

[48] Vijay Pant, Morgan Stanley Risk Management, "Specification for Short Term Exposure Model," December 4, 2004. GARCH stands for Generalized Autoregressive Conditional Heteroscedasticity. Mandelbrot acknowledges the statistical usefulness of GARCH models but prefers fractal generator models. Mandelbrot, Hudson, pp. 221-2.

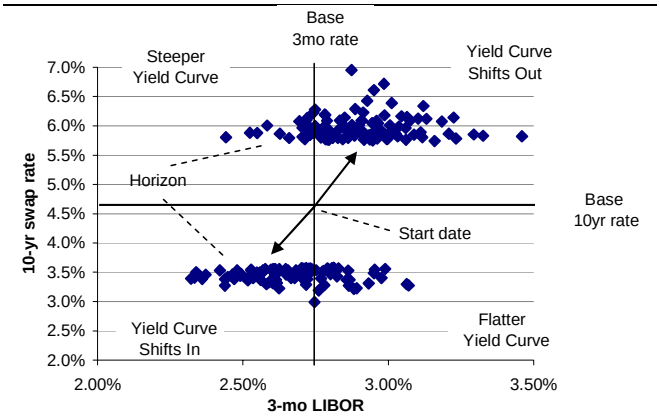
Please see analyst certification and other important disclosures starting on page 58.

distribution of coupons in the market; [49] because of their size, we reasoned, the GSEs' portfolios would likely resemble the market.

We had hoped to value this portfolio across all 50,000 scenarios, but discovered that the computational resources would exceed our budget. So we used a simple model of a duration-matched MBS security to rank-order the 50,000 from easiest to worst shocks and selected the most severe 200 for Applied Financial Technology to value.[50] These 200 scenarios consisted of roughly equal proportions of shocks in upwards and downwards directions (Exhibit 24).

Exhibit 24

Profile of 200 Shock Scenarios



Source: Morgan Stanley Research

Our interest rate shock scenarios seem reasonable compared to regulatory standards. For some perspective, the worst 200 scenarios out of 50,000 from our GARCH model amounted to one-month shocks of around 100-200 bps. Basle II does not proscribe formulae for assessing interest rate risk. But the regulations recommend that supervisors consider a standardized rate shock equal to an upward and downward 200 basis point parallel rate shock. Regulators are encouraged to pay special attention to firms that would lose more than 20% of their capital under this test.[51] The Office of Thrift Supervision subjects thrifts to immediate parallel interest rate shocks of 200-300 bps and expects them to survive that shock with at least 400 bps of capital to assets.[52]

Using an interest rate model based on the normal distribution for risk management purposes would be a mistake, in our view. For the purposes of day-to-day trading, Morgan Stanley's fixed-income department uses a discrete Heath-Jarrow-Morton model to value bonds and interest rate derivatives. This model uses a "risk-neutral" distribution of interest rates, which assumes a normal or lognormal curve, and is calibrated to the yield curve and implied volatility. HJM is a popular model because its distribution fits historical interest rate data.[53]

However, over a one-month time horizon, the GARCH model generates much wider tails than the HJM model. For the analysis we're doing, where the focus is on low-probability scenarios, the difference in shocks is significant. To compare the models, we had each produce a set of 10,000 interest rate paths, starting at the same point in time and running one month forward. For the GARCH model, the 9,500th biggest shock out of 10,000 random paths (corresponding to the 95% probability level) was a jump of 59 bps, compared to 48 bps for the HJM model (Exhibit 25). The biggest shock out of the 10,000 was 164 bps for the GARCH model, more than 1.5 times as large as the 102 bp-shock for the HJM.

Exhibit 25

Profile of Random One-month Interest Rate Shocks Generated by Rival Interest Rate Models

1-month shocks to 10-yr swap rates, in basis points

Probability	GARCH	HJM
95%	59	48
99%	87	64
99.99%	165	102

Based on generation of 10,000 random interest rate paths.
Source: Morgan Stanley Research

Conversations with major financial institutions suggest that some are in fact using HJM or similar models for risk management purposes. If this is so, then they may be failing to capture fat tail risk.

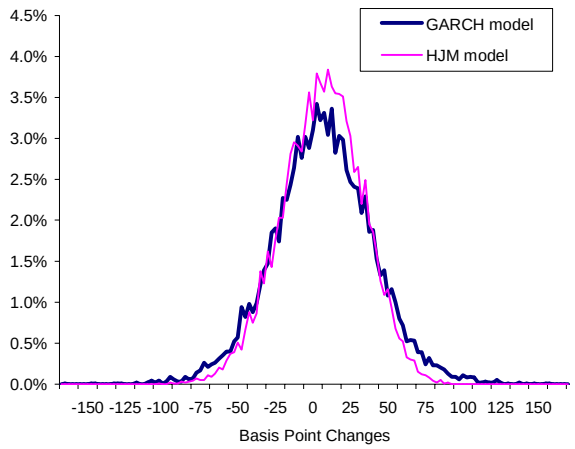
[49] Under the assumption that Fannie and Freddie are so large that the composition of their retained portfolios mimics the market, we used a mix of coupons consistent with outstanding MBS as of the analysis date of 2/1/05, roughly 3.9% 4.5, 29% 5.0, 42% 5.5, 17% 6.0, 5.5% 6.5, 2.5% 7.0.
[50] We built a two-variable regression model to value a MBS with duration match-funded debt as a function of shocks to 10-year yields and the slope of the yield curve using Bloomberg data and analytics. We used this model to sort the 50,000 scenarios into the 200 most severe. These were by and large characterized by the most extreme movements on the long end of the curve; fluctuations in the yield curve had a smaller effect on MBS values.
[51] Basel Committee on Banking Supervision, *Principles for the Management and Supervision of Interest Rate Risk*, Bank for International Settlements, July 2004, p. 25.

[52] "The Quarterly Review of Interest Rate Risk," Office of Thrift Supervision, Volume 9, Issue 2, Second Quarter, 2004.
[53] Kyle G. Lundstedt, Mark B. Williams, "Comparing Rate Processes," VaRisk, Inc., 8/25/03.

While we have little information about the types of models the GSEs use, a Moody's report states that they employ "multi-factor arbitrage-free models,"[54] another term for models that rely on the normal or risk neutral distribution. This would be logical from the perspective of pricing and trading, but would be worrisome if they served as the basis for their risk management or economic capital models. Freddie Mac told us that its economic capital model is based on the risk-neutral distribution but adjusted to allow for drift in volatility.

Exhibit 26

GARCH v. HJM Interest Rate Distributions-10yr Swap Rate



Distribution of one-month forward changes in the 10-year swap rate, based on 10,000 random scenarios.
Source: Morgan Stanley Fixed Income Research

Historical simulations should also be suspect. Under value-at-risk methodologies used to calculate economic capital, firms may estimate the volatility of security prices using a short period of historical observations, say four or five years. Nassim Taleb argues that statistical risk management of this sort "is charlatanism because it tries to estimate something that is not scientifically possible to estimate, namely the risks of rare events."[55] Even without agreeing with Taleb's characterization, one should recognize that a four- or five-year time period might not include an episode of high volatility. In this case, extrapolating from a relatively calm period might leave the institution unprepared for an uncommon, severe shock.

There are other, more subtle problems with historical analysis. For example, as a Federal Reserve study noted, historical simulation approaches may be unresponsive to changes in volatility. That is to say, even when the four-year period includes a major shock, the simulation model may weight it as only one day's movement out of four years, thus failing to pick up one what might be a major shift in volatility. Even worse: historical models sometimes focus on losses; so large gains, which may imply a dangerous increase in volatility, may be ignored.[56]

Even longer-term historical studies may be problematic. For example, a study by R. Glenn Hubbard on Fannie's default risk strikes us as employing a questionable historical methodology. Hubbard used a bootstrap methodology to sample rate changes from the historical period 1982-2003. One problem with Hubbard's approach: the volatility of interest rates has steadily climbed over the last 20 years (see Exhibit 46, below). Bootstrapping from the distribution would therefore result in a lower average volatility than the market is experiencing and expecting today. Another problem is that Hubbard excluded the period 1979-1982 because it included a "change in the conduct of U.S. monetary policy" which Hubbard considers "atypical."[57] The characterization of Fed policy is fair enough, but who's to say with certainty that the Federal Reserve won't change policy again in the future? We imagine that for any span of history, there would be some reason for excluding periods characterized by high volatility. However, to exclude these periods as outliers goes against the spirit of risk management, because the whole point is to be prepared for the unusual or unexpected. We'll have more to say about the Hubbard study below.

On a final point, the study of history is useful for the purpose of conducting stress-test analysis. As noted, history is not a perfect guide to the future. But firms can start thinking about the future by examining how their current strategies would have performed in the worst crises of past years. For a portfolio of MBS, stress tests could include the 100-bps interest-rate shock of July 2003, conditions in the aftermath of the terrorist attacks of 9/11/2001, the global currency crisis of 1998, the rapid Fed tightening cycle of 1994-5, and — again, begging to disagree with Mr. Hubbard — the inflationary shock of the late 1970s and early 1980s.

[54] Moody's, p. 8.
[55] "The World According to Nassim Taleb," *Derivatives Strategy*, 1996. For a discussion of the "rare event fallacy," i.e., why statistical methods do not assess the correct probabilities of rare events, see Nassim Taleb, *Fooled By Randomness: The Hidden Role of Chance in the Markets and in Life*, 2001, pp. 93-110.

[56] Matthew Pritsker, "The Hidden Dangers of Historical Simulation," Board of Governors of the Federal Reserve System, June 19, 2001.
[57] R. Glenn Hubbard, "The Relative Risk of Fannie Mae," *FannieMae Papers*, Volume III, Issue 3, September 2004, Technical Appendix B, p. 2.

Please see analyst certification and other important disclosures starting on page 58.

Negative Convexity and Interest Rate Risk Capital for MBS

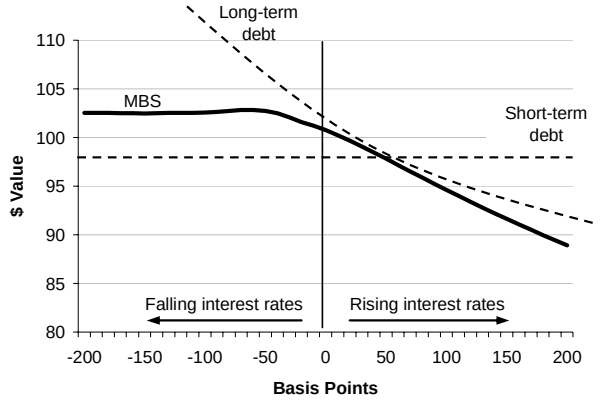
For an unhedged portfolio of MBS held by a AA/A-rated financial institution, we estimate a capital requirement of approximately 8%. This ratio is the first in a series of step-by-step calculations covered in this and following sections where we evaluate the capital appropriate for each source of risk (see Exhibit 20 above). In this section, we evaluate the most basic measure of interest-rate risk for MBS, "negative convexity," before considering hedges or more complex risk factors, like basis, liquidity, or model risk.

Duration and negative convexity risk. Exhibit 27 presents a simplified representation of the value of a portfolio of MBS against changes in interest rates in order to illustrate the two principal underlying sources of risk. First, MBS tend to increase in value when interest rates decline, but lose value when interest rates rise. Fixed-income analysts refer to the sensitivity of a security's value to changes in interest rates as "duration." The duration of MBS is roughly similar to that of the fixed-rate bonds also illustrated in the diagram, and both contrast with the profile for short-term bonds, which show little or no sensitivity to interest rate changes because their coupons continually reset to the current market interest rate.

Second, compared to the fixed-rate bond, the MBS profile features a pronounced asymmetry: MBS tend to gain very little value when rates drop. The reason for the asymmetry is that when rates drop, consumers tend to refinance their mortgages; the investor thus receives the principal back, rather than continuing to receive the coupon on the underlying mortgages, and this prepayment behavior has the effect of shortening the expected duration of the MBS. The sensitivity of MBS duration to changes in interest rates is known as "negative convexity," and contrasts with a small degree of positive convexity in most other fixed-rate bonds, which cannot normally be refinanced.

Exhibit 27

Negative Convexity

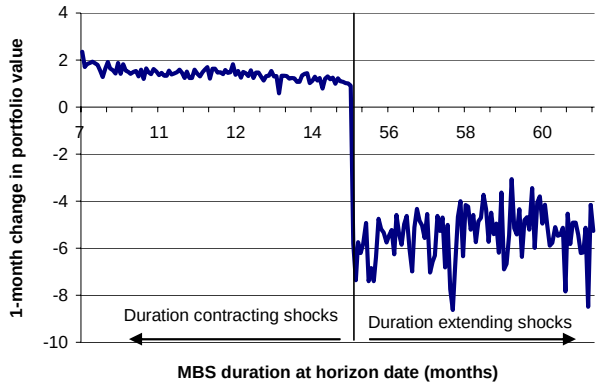


Source: Morgan Stanley Research

How much capital should be held against negatively convex MBS? To answer this question, we turn to the economic capital framework, which specifies the capital necessary to cushion against various levels of loss. Exhibit 28 below shows the change in value for our GSE-representative portfolio in the 200 shock scenarios which Applied Financial Technology valued for us. The left side of the chart shows the value of MBS in scenarios that have the effect of contracting MBS durations (these tend to be characterized by falling interest rates). The right side of the chart shows the value of MBS in scenarios that have the effect of extending MBS durations (these tend to be characterized by rising interest rates; however, because the scenarios include changes in both the short and long end of the curve, we cannot label the axis with one set of interest rates). As we would expect, the MBS have lost significant value in the extension (or rising rate) scenarios, but gained slightly in the duration contraction scenarios, consistent with the concept of negative convexity discussed above.

Exhibit 28

200 Shock Scenarios for a Portfolio of Unhedged MBS

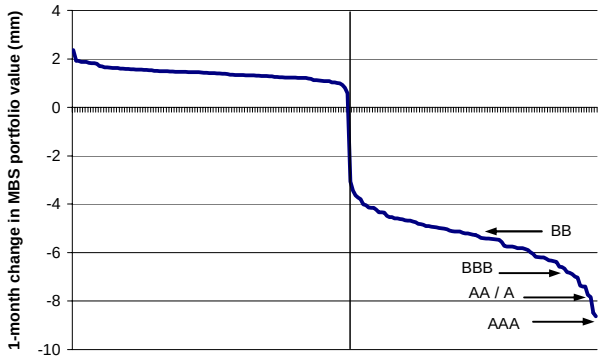


Note: Duration extension shocks refer to generally rising interest rate scenarios which have the effect of slowing prepayment speeds, whereas contraction shocks refer to generally falling rate scenarios. At the start date, the MBS portfolio in this analysis had an estimated duration of 36 months.

Source: Applied Financial Technology, Morgan Stanley Research

Exhibit 29

Losses and Capital Requirements for MBS Portfolio, With 200 Scenarios Sorted from Best to Worst



Source: Applied Financial Technology, Morgan Stanley Research

The question of how much capital should be held against this risk is answered by finding the scenario that corresponds to the frequency appropriate for the target debt rating (Exhibit 29 illustrates the concept and Exhibit 30 summarizes the results).

- To figure the capital necessary for the AAA rating, we need a scenario whose probability corresponds to the frequency with which AAA-rated firms default, which we estimate at only 0.025% (2.5 bps) per year. Converting this annual frequency to a monthly frequency, we divide by 12, resulting in a monthly frequency of 0.2 bps. This corresponds, by design, to the single worst scenario out of the 50,000 random interest rate paths generated by the GARCH model. In the random data we generated, the worst scenario involved a 194 bp shock to the 10-year rate, with the shape of the yield curve steepening. In this case, the MBS portfolio lost approximately 8.6% of its value, and thus the capital needed to guard against this remote scenario is 8.6%.

- For the AA/A rating, we used the third worst scenario, because its probability corresponds to 0.5 bps on a monthly basis or 6 bps annually. The loss associated with this scenario and thus the capital required to protect against it is 7.8%.

- For the BBB rating, we used the 13th scenario, corresponding to an annual probability of 0.31%. Required capital is 6.7%.

- For the BB rating, the 58th scenario, equivalent to an annual probability of 1.39%, generates a capital requirement of 5%.

Exhibit 30

Capital Standards for Unhedged MBS Interest Rate Risk

	Approximate Rating			
	AAA	AA/A	BBB	BB
Annualized (bps)	2.5	6	31	139
Implied monthly (bps)	0.2	0.5	2.6	11.6
Scenario (of 50,000)	1	3	13	58
Scenario loss / capital requirement	8.6%	7.8%	6.7%	5.0%

Note: MBS portfolio duration equals 37 months.
Source: Morgan Stanley Research

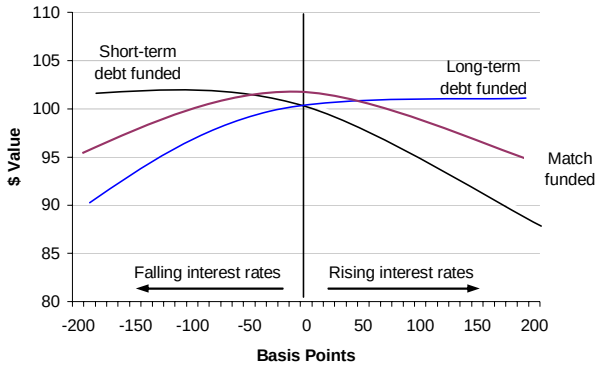
As a reminder, these estimates do not reflect the risk associated with volatility in MBS spreads, which would affect mark-to-market values, but not the cash flows that a hold-to-maturity investor would collect over the life of the assets. Also, these estimates do not include capital for model risk, basis risk, or liquidity risk, but neither do they do not give any credit for the use of hedges. We will discuss these issues in the following sections as we develop more complete and realistic capital requirements.

Duration Matching

Under our economic capital framework, the use of match-funded debt cuts the capital ratio in half, to roughly 3.5% for a AA/A-rated institution. The previous analysis did not consider the financing strategy for the portfolio; implicitly it assumed that the portfolio was funded with short-term debt[58] — a strategy long recognized as imprudent. Using match-funded debt, i.e., debt whose duration matches that of the MBS, helps even out the risk, trading a significant exposure to rising rates for a more moderate exposure to both falling and rising rates (Exhibit 31). As a caveat, if we had considered more sophisticated duration hedging strategies, the ratio might have come out even lower.

Exhibit 31

The Benefit of Match-Funded Debt: Illustrative Example



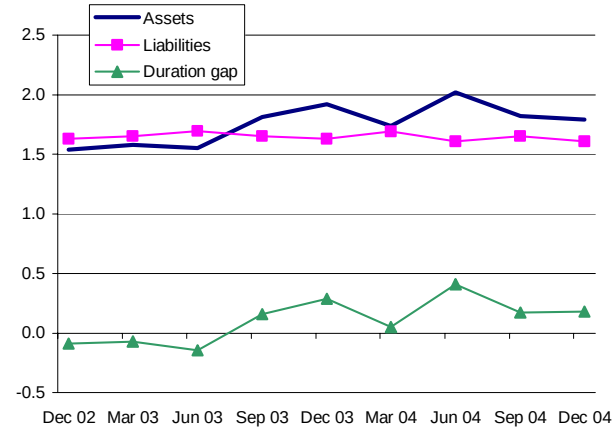
Source: Morgan Stanley Research

Financing mortgages with short-term debt is dangerous. In the 1970s, the risk was not well-recognized, and most savings and loans funded their portfolios of fixed-rate mortgages with short-term deposits. When interest rates rose abruptly in the late 1970s and early 1980s, the S&Ls were squeezed, because their funding costs increased, but the coupons on their mortgages did not. Media accounts of the ensuing crisis tended to focus on risky investments, bad accounting, and fraud.[59] But the real cause was borrowing short and lending long.[60] Stock market investors appeared to understand this risk: one study found that S&L stocks reacted to interest rate shocks in proportion to the mismatch between the duration of their assets and liabilities.[61]

Today, thrifts take on much less interest rate debt. According to the Office of Thrift Supervision (OTS), the average "duration gap" (i.e., the difference between the duration of the assets and the liabilities) for the S&L industry has been running sometimes a little above, sometimes a little below, but generally close to zero months (Exhibit 32). In contrast, during the 1970s, the duration gap may have been close to five or seven years, we imagine, because most of the deposits were short-term in nature, and because consumers did not refinance loans as frequently as they do today, so the expected durations of fixed-rate mortgages were probably longer than they are today.

Exhibit 32

Duration Gap for the US Thrift Industry (years)



Source: Office of Thrift Supervision

The GSEs' duration gap generally ranges near zero. In the early 1990s, Fannie Mae struggled with a duration mismatch problem just like the S&Ls. (Freddie Mac had avoided taking on interest rate risk.) Since then, the GSEs have mostly kept their duration gaps much closer to zero (Exhibit 33). Mostly, but not always.

[58] The fair value of short-term debt is relatively insensitive to interest rate shocks (since the coupon quickly resets to the new level of rates). As such, looking at the change in MBS values without reference to debt, as we did in the last section, gives roughly the same answer as assuming the portfolio is funded with short-term debt (whose value does not change).

[59] For example, Kathleen Day, *S&L Hell: The People and Politics Behind the $1 Trillion Savings and Loan Scandal*, 1993.

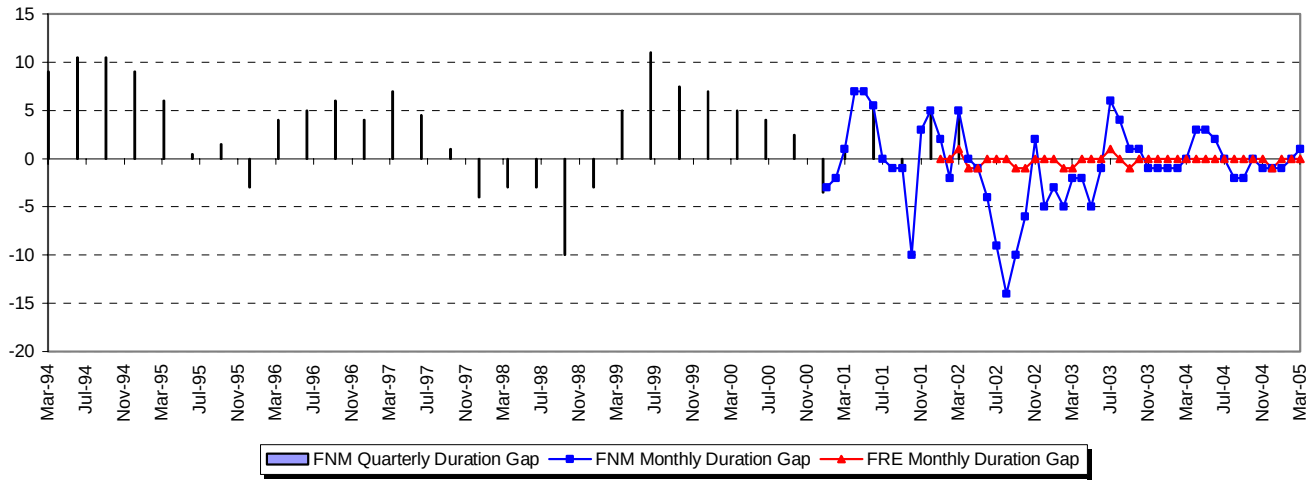
[60] George J. Benston, *An Analysis of the Causes of Savings and Loan Association Failures*, Salomon Brothers Center for the Study of Financial Institutions, New York, 1985.

[61] Mark J. Flannery, Christopher M. James, "The Effect of Interest Rate Changes on the Common Stock Returns of Financial Institutions," *The Journal of Finance*, Vol. XXXIV, No. 4, September 1984.

Please see analyst certification and other important disclosures starting on page 58.

Exhibit 33

Duration Gap (Months) for the GSEs Has Mostly, But Not Always, Stayed Close to Zero



Note: Freddie Mac's duration gap represents averages for the month. Fannie Mae duration gap switched from end-of-month to monthly average beginning March 2003.

Source: Company Disclosures

In September 2002, in the wake of a surprisingly large decline in interest rates, Fannie Mae disclosed that its duration gap had fallen to -14 months. Its debt spreads immediately widened by 20 bps. One month later, when the duration gap improved to -10 months, Fannie's debt spreads narrowed by almost 10 bps. Evidently, debt investors became concerned about the company's risk profile while its duration gap was in extended territory.[62] (Since Fannie Mae has a lower capital cushion than the average thrift, the risk profile associated with this duration gap is more worrisome than the same duration gap would be for a thrift.). Subsequently, Fannie elected to tighten its hedging standards to +/- 6 months. Freddie has long kept its duration gap within a range of +/- 1 month.

Nonetheless, taking on duration risk can be tempting, because that strategy boosts the net interest margin and GAAP earnings, at least so long as interest rates do not move. Exhibit 34 shows how the margin might vary with the duration gap for the GSE-like portfolio of MBS we have modeled. A firm that borrowed short and lent long would enjoy an enormously wide margin, more than twice as wide as one that precisely match-funded its debt. This margin would help it generate impressive returns, but at the expense of heightened risk. If interest rates rose, its margin would get squeezed, just like a thrift from the 1980s.

Exhibit 34

Net Interest Margin as a Function of Duration Gap

	Annual	
MBS	5.49%	
Debt Cost	2.77%	
Duration Gap	Swap Cost	NIM
0 mos	0.52%	2.20%
1 mos	0.51%	2.22%
2 mos	0.49%	2.23%
3 mos	0.47%	2.25%
6 mos	0.41%	2.31%
9 mos	0.36%	2.36%
12 mos	0.30%	2.42%
28 mos	0.00%	2.72%

Note: These margins are not comparable to the net interest margins disclosed by the GSEs because these numbers do not include the cost of convexity hedging or the effect of interest rate shocks, which would tend to compress the margin over time.

Source: Applied Financial Technology, Morgan Stanley Research

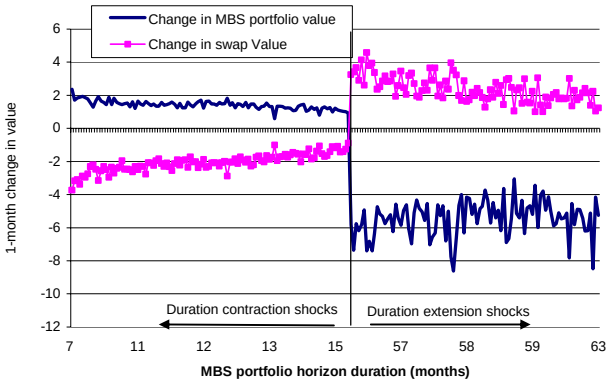
We can modify the risk profile of our MBS portfolio by funding it with a mix of debt whose duration approximates that of the underlying mortgages. Exhibits 35 and 36 show the risk profile for the MBS portfolio and a 5-year swap in the 200 worst scenarios. The swap's risk profile moves in the opposite direction, indicating that changes in interest

[62] Robert S. Seiler, "Market Discipline of Fannie Mae and Freddie Mac: How Do Share Prices and Debt Yield Spreads Respond to New Information?" OFHEO Working Papers 03-04, December 2003, p. 38.

rates have the opposite effect on it. Exhibits 37 and 38 show the value of the portfolio (i.e., MBS less debt) across the 200 stress scenarios for three funding strategies: 1) completely short-term debt, where the duration gap is equal to approximately 36 months, i.e., the duration of the underlying MBS, 2) using a 5-year swap to lengthen the effective maturity of the debt, resulting in a duration gap of 12 months, and 3) a perfectly matched funding strategy, where the duration of the debt equals that of the assets, resulting in a duration gap of approximately zero months.[63] It should be clear from the chart that the level of losses is the lowest under the third strategy. Exhibits 37 and 38 contrast the resulting required capital at the AA, A, and BBB standards for a range of duration gaps.

Exhibit 35

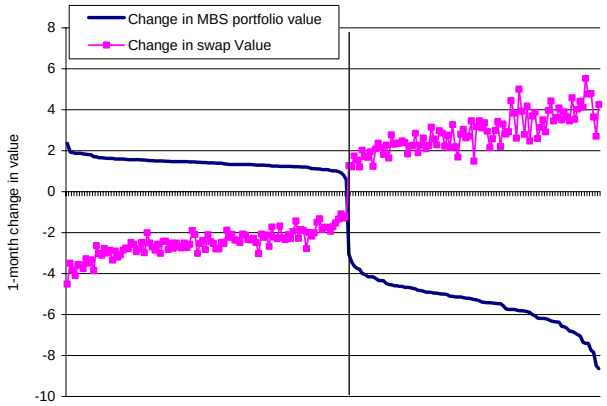
Risk Profile Under Stress Scenarios:
MBS Portfolio v. 5-year Swap



Source: APPLIED FINANCIAL TECHNOLOGY, Morgan Stanley Research

Exhibit 36

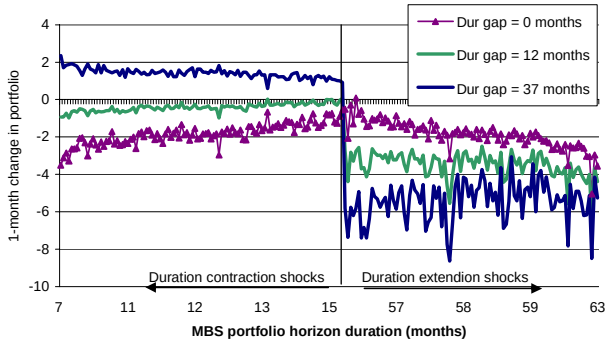
Risk Profile Under Stress Scenarios:
MBS Portfolio v. 5-year Swap, Sorted from Best to Worst



Source: APPLIED FINANCIAL TECHNOLOGY, Morgan Stanley Research

Exhibit 37

Risk Profile Under Stress Scenarios:
Funding at 36-month, 12-month, and Zero Duration Gaps



Note: In our calculations, "approximately zero" is actually -4 month duration gap.

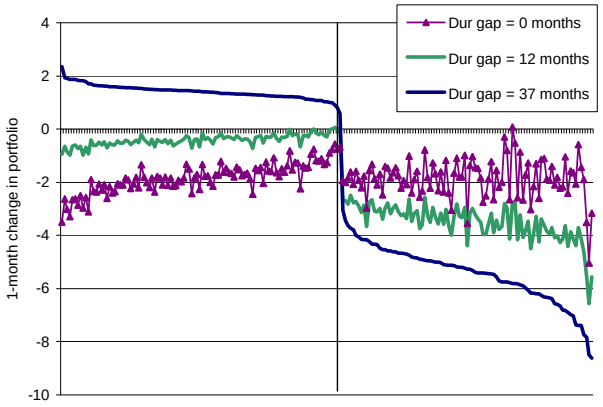
Source: APPLIED FINANCIAL TECHNOLOGY, Morgan Stanley Research

[63] As we discuss below, a single duration measure does not capture the sensitivity of the portfolio to rate shifts at different points along the yield curve and is thus only an approximate guide to match-funding and other hedges. In the analysis in this section, "approximately zero" refers to a duration gap of -4 months, which we found optimal for the portfolio.

Please see analyst certification and other important disclosures starting on page 58.

Exhibit 38

Risk Profile Under Stress Scenarios: Funding at 36-month, 12-month, and Zero Duration Gaps, Sorted from Best to Worst



Source: Applied Financial Technology, Morgan Stanley Research

Exhibit 39

Capital Requirements as Function of Duration Gap

	Approximate Rating			
	AAA	AA/A	BBB	BB
Annual default rate (bps)	2.5	6	31	139
Implied monthly default rate (bps)	0.2	0.5	2.6	11.6
Scenario (of 50,000)	1	3	13	58
Scenario loss / capital requirement				
Base duration = -4 months	5.1%	3.5%	2.9%	2.1%
Increase from base: + 1 month	5.1%	3.6%	2.8%	2.1%
+2 months	5.5%	3.9%	3.0%	2.2%
+3 months	5.7%	4.2%	3.3%	2.3%
+6 months	6.0%	4.7%	3.5%	2.7%
+9 months	6.3%	5.1%	3.8%	2.9%
+12 months	6.6%	5.6%	4.1%	3.2%
+24 months	7.7%	7.1%	5.6%	4.4%
28 months	8.1%	7.7%	6.2%	4.9%
37 months	8.6%	7.8%	6.7%	5.0%

Source: Morgan Stanley Research

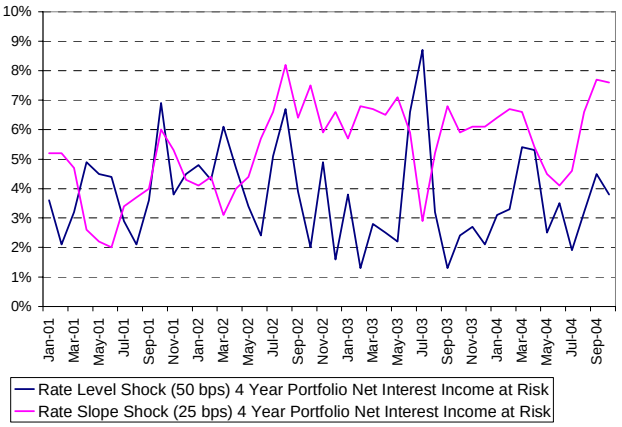
Yield curve shifts complicate duration-matching. The careful reader will note that the change in swap values does not precisely offset the change in MBS values across all of our two hundred shock scenarios. One reason for this is that MBS and swaps may react differently to shifts in the yield curve. The reason is that fixed-rate MBS prepayment speeds are sensitive to the attractiveness of adjustable-rate mortgages as an alternative product: in steep yield curves, consumers may swap out of their fixed-rate loans into adjustables. Another reason is that we are looking at duration defined in regard to changes in the 10-year swap rate. A more thorough approach would use "key rate duration" to examine the sensitivity of the two securities to changes in rates at different points along the curve.[64] In our analysis, we used a single 5-year swap to adjust the duration of the portfolio. If we had used a basket of swaps with different maturities, we could probably have reduced the capital requirements somewhat further.

Fannie Mae's interest rate risk disclosures reveal how the company has traded off exposure to parallel and yield curve shocks. Exhibit 40 shows a time series of its "net interest income at risk" metric for both parallel shocks and shifts to the yield curve. Statistical analysis reveals a faint negative relationship[65] between these two metrics, suggesting that the company may not have found it practicable to hedge both risks at the same time. Freddie Mac's recent PMVS disclosures (not shown here) suggest that the company has minimized its exposure to yield curve shocks.

Exhibit 40

How Fannie Mae Has Traded Off Exposure to Parallel Rate Shocks Against Exposure to Yield Curve Shocks

Fannie Mae's Net-Interest-Income-at-Risk



Net interest income at risk refers to the percentage of net interest income the company projects over the next four years that would be lost in a parallel rate shock of 50 bps or a 25-bp shock to the shape of the yield curve.

Source: Company disclosures

[64] For a technical discussion, see Bennett W. Golub, Leo M. Tilman, *Risk Management: Approaches for Fixed Income Markets*, 2000.

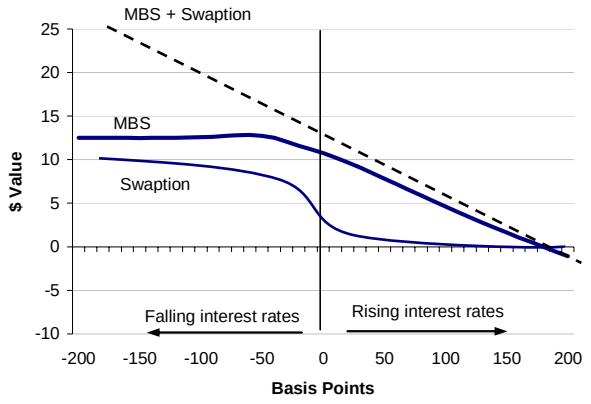
[65] In a linear regression of the relationship between the four-year level and slope shock disclosures, the T-statistic is -1.63, indicating that the negative relationship is statistically valid at the 89% confidence level. The r-squared is 6%.

Hedging Convexity with Options and Dynamic Hedging

Our analysis leads us to subtract approximately 50 bps from the capital ratio for MBS under the assumption that roughly 75% of the convexity risk is hedged with options. As we saw in the last section, using match funded debt helps reduce the risk associated with holding MBS, but it does not eliminate the negative convexity problem. One of the reasons that fixed-rate mortgages are so popular in the US is that the borrower enjoys an option to refinance, allowing him or her to take advantage of interest-rate volatility to lock in low borrowing costs. Conversely, one of the reasons that the interest-rate risk associated with MBS is so controversial is that the lender or investor is "short" that same refinance option. To mitigate the risk of being short the option, a GSE or other investor may purchase interest rate options, in this way helping to "straighten out" the asymmetric profile of MBS (Exhibit 41). As a caveat, our analysis is not as efficient as is theoretically possible: a different choice of options might have allowed us to reduce the capital cushion further. Also, the 75% hedging ratio is a tougher standard than what the GSEs have historically practiced (especially Fannie) — this assumption reflects our view that a new regulator will insist on less dynamic hedging.

Exhibit 41

Options Help "Straighten" Out the Negative Convexity of MBS: An Illustrative Example



Swaption should not be worth 100 - can we revise as par

Source: Morgan Stanley Research

From the perspective of capital requirements, options function like an insurance policy, helping to mitigate some of the risk in the portfolio. Since options and capital both reduce the risk of insolvency, they can be thought of as substitutes: more options means less risk, hence less capital should be needed.[66] In practice, provided that firms establish clear policies about the use of options to mitigate risk, rather than speculate, and provided that regulators are able to monitor the use of options, the capital requirement ought to be lowered accordingly. In fact, the GSEs' current risk-based capital standard gives explicit recognition to the benefit of options, although as we pointed out above, the model appears to be too generous.

Fannie and Freddie have long issued callable debt to hedge convexity risk: if interest rates fall, leading to refinancings and downward pressure on the GSEs' net interest margins, they can call their outstanding debt and reissue it with a lower coupon, thus offsetting the margin pressure. The GSEs also purchase stand-alone interest rate options in the exchange-traded and over-the-counter derivatives markets. The GSEs' disclosures show that they are big purchasers of caps and swaptions.

The alternative to purchasing options is to "dynamically hedge" the portfolio by continually rebalancing. While this strategy may be quite effective, at least in normal environments, it does not warrant regulatory capital relief, in our view. The reason that regulators would not be comfortable with this approach is that it is precisely in the "fat tails" of the distribution, i.e., when the market is suffering from an extreme shock, that this kind of approach can break down, either through execution mistakes or from problems with market liquidity. Since the capital standard is meant to protect the firm from extreme scenarios, dynamic hedging cannot be counted on like an equity cushion. We will discuss issues with dynamic hedging in this section and in the section on swaps market liquidity.

Hedging away all convexity risk would be expensive and impracticable. The reason is that there is a cost to hedging. If we amortize the premiums paid to purchase the swaptions, we find a significant effect on the net interest margin (Exhibit 42 below). Taken to the extreme, hedging 100% of the convexity risk would reduce the net interest margin to zero. Based on conversations with the GSEs' managements and market participants, we estimate that they typically hedge between 40% and 70% of the convexity in their portfolios. This assumption appears consistent with the

[66] Robert C. Merton, Andre F. Perold, "Theory of Risk Capital in Financial Firms," *Continental Bank Journal of Applied Corporate Finance*, Fall 1993.

range of net interest margins the companies disclosed in past years.

Also, the market in options is limited in size. According to dealers, Fannie and Freddie already account for more than half the demand for options in the market. Further, the GSEs rely on the four largest options dealers for 40 to 55% of their purchases. When these dealers are in the process of rebalancing their books, their capacity to take on more risk may be limited, and their ability to sell additional options may be constrained. In the past, the GSEs have opted to suspend purchases of options during periods when market pricing was unattractive to them.[67]

Exhibit 42

Net Interest Margin as a Function of Convexity Risk

	Convexity				
	0%	25%	50%	75%	100%
MBS	5.49%	5.49%	5.49%	5.49%	5.49%
- Debt Cost	2.77%	2.78%	2.79%	2.80%	2.82%
- Swap cost	0.52%	0.64%	0.75%	0.86%	0.97%
- Swaption cost	0.00%	0.42%	0.84%	1.26%	1.68%
NIM	2.20%	1.66%	1.11%	0.57%	0.03%

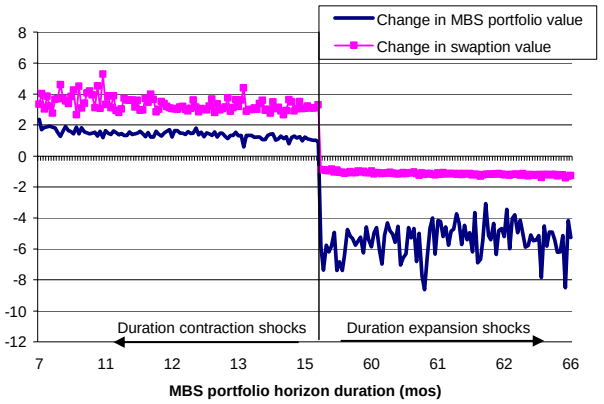
Note: Option cost is amortized as reduction of net interest margin; this treatment reflects historical GAAP before FAS 133. Assumes approximately zero duration gap. These margins are not comparable to the net interest margins disclosed by Fannie Mae and Freddie Mac because these margins do not include the effect of interest rate shocks over time.

To model the effect of interest rate options on capital requirements, we used a mix of swaptions to partially offset the convexity in the MBS portfolio. As exhibit 43 shows, the value of a swaption rises in the duration-contraction scenarios, helping to offset the loss in value experienced when borrowers refinance their loans. The swaptions are now "in the money." In extension scenarios, the swaption value drops close to zero. The swaption is "out of the money," and the remaining value reflects what is now only a remote chance that interest rates might drop far enough to get them back into the money. Adding swaptions to the portfolio helps mitigate losses and thus reduces the need for capital (Exhibits 44 and 45).

Our analysis may be conservative. A quick glance at Exhibit 44 shows that the portfolio still suffers from negative convexity in the extreme rate shock scenarios, despite our use of swaptions. On the far left and far right side of the chart, where the rate shocks are most extreme, the portfolio is still suffering significant losses, whereas in the center of the chart, where the rate shocks are more moderate, the portfolio is in a positive position. One limitation of our analysis is that our calculations are based on a package of only three different options: at-the-money 3 month x 10 year, 3 year x 10 year, and 3 year x 5 year swaptions. If we had considered a wider range of hedging strategies, we might have been able to reduce the capital cushion somewhat further. In particular, the use of out-of-the-money swaptions might have given us more protection in the extreme scenarios, where we need it the most, and less in the moderate scenarios, where protection is less important.

Exhibit 43

Risk Profile Under Stress Scenarios: MBS Portfolio v. Swaptions



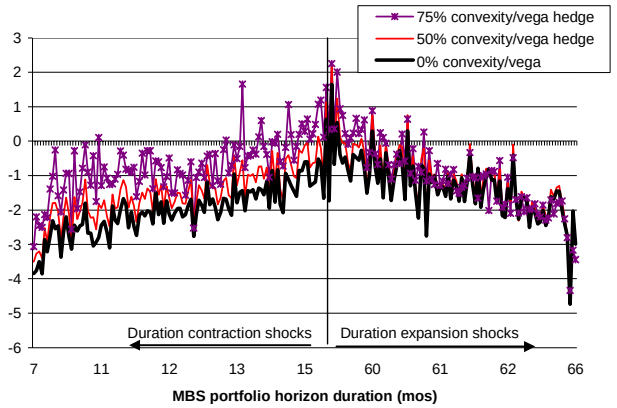
Note: Swaption value represents portfolio of 3mo x 10yr swaption, 3yr x 10yr swaption, and 3yr x 5yr swaption.

Source: Applied Financial Technology, Morgan Stanley Research

[67] Staff of the Board of Governors of the Federal Reserve Systems and the Federal Reserve Bank of New York, "Concentration Risk in the OTC Markets for U.S. Dollar Interest Rate Options," March 2005, pp. 2, 4. For a discussion of risk positions of options dealers, see John Kambhu, Patricia Mosser, "The Effect of Interest Rate Options Hedging on Term-Structure Dynamics," *FRBNY Economic Policy Review*, December 2001.

Exhibit 44

Swaptions Mitigate Negative Convexity Risk



Note: Starting duration gap is approximately zero.
Source: APPLIED FINANCIAL TECHNOLOGY, Morgan Stanley Research

Exhibit 45

Capital as a Function of Convexity Risk

	Approximate Rating			
	AAA	AA/A	BBB	BB
Annual default rate (bps)	2.5	6	31	139
Implied monthly default rate (bps)	0.2	0.5	2.6	11.6
Scenario (of 50,000)	1	3	13	58
Scenario loss / capital requirement w/ convexity/vega hedge =				
0%	4.7%	3.8%	2.9%	2.1%
25%	4.6%	3.4%	2.5%	1.8%
50%	4.5%	3.2%	2.4%	1.5%
75%	4.4%	3.2%	2.3%	1.2%
100%	4.3%	3.2%	2.3%	1.1%

Note: Assumes approximately zero duration gap. Hedges include mix of 3 month X 10 year, 3 year X 10 year, and 3 year X 5 year swaptions.

Dynamic Hedging

Instead of purchasing options, an investor might dynamically hedge an MBS position by continually rebalancing. Every movement in interest rates changes the prepayment pattern for an MBS and thus its expected duration. But the duration of debt and swaps is not as sensitive. Thus an interest rate shock, even a small one, may throw off the net duration gap of the portfolio. To rebalance the portfolio requires adjusting the duration of the liabilities to match the new duration of the MBS. This is often accomplished by entering into a new swap transaction. If an investor executed this strategy flawlessly, it would never suffer from convexity risk, and it wouldn't need much capital. Some have argued that management action should be considered in setting capital standards.[68]

However, a regulator would have a hard time giving capital credit for a dynamic hedging strategy, in our view. For one, no-one rebalances flawlessly. As Alan Greenspan points out, "the problem is that dynamic risk hedging is a very precarious activity and a lot of things have got to go right. And numbers of times things go wrong."[69] Another problem in trying to give credit for dynamic hedging would be the question of how committed the financial institution is to following that strategy. Does the institution have policies establishing tolerances for the duration gap? How are these policies monitored and enforced? Do the policies give the regulator legal justification to intervene if they are not followed? Fannie and Freddie have established policies and disclose the duration gap once a month. But a lot of things could happen in a month. During an extreme rate shock scenario, characterized by strains on swap market liquidity (more on this below), the institutions would have to make decisions about rebalancing immediately or waiting for better liquidity to develop. They might put off rebalancing at precisely the point when the regulator was counting on them to toe the line. In our various anecdotal conversations with regulators, we have never found one who was open to giving capital credit for dynamic hedging.

Another problem with the Hubbard study, in our view, is that it takes Fannie's dynamic hedging strategy at face value in estimating the company's risk profile. It does this by constructing a regression model to predict the behavior of Fannie's duration gap based on changes in interest rates.[70] But in using this model during the stress analysis, the Hubbard study assumes that Fannie's hedging strategy will be executed just as successfully in all possible scenarios in the future as it has been in the past. To us, this seems an enormous leap of faith — one that we do not foresee a new regulator embracing.

Rather than giving capital relief for dynamic hedging, our framework assumes that the GSEs rebalance and penalizes them if they do not. As noted above, as the duration gap begins to move away from zero, the portfolio's exposure to interest rate changes becomes lopsided, the risk of severe losses increases, and more capital becomes necessary. Under this framework, if the GSEs did not keep their duration gap close to zero, they would need more capital. Thus they have every incentive to dynamically hedge. But it is only by purchasing options that they should be able to reduce their capital requirement.

[68] Chris Marrision, Til Schuermann, John D. Stroughair, "Changing Regulatory Capital to Include Liquidity and Management Intervention," *The Journal of Risk Finance*, Summer 2000.

[69] Senate Banking, Housing and Urban Affairs Committee Holds Hearing on Revising Regulation of Government Sponsored Enterprises, Congressional Transcripts, April 6, 2005, p. 21.

[70] Hubbard, Technical Appendix B, pp. 3-4.

Interest Rate Volatility and "Vega" Risk

Our calculations suggest a AA/A-rated institution should hold about 0.7% capital against the vega exposure of an MBS portfolio. "Vega" is a fixed-income term that refers to the sensitivity of a portfolio or security to changes in volatility. The loss estimates and capital requirements we noted above, where MBS losses were offset to varying degrees by swaptions used as convexity hedges, depended on an assumption about volatility, which we made based on the level of volatility implied in the pricing of interest rate derivatives as of the date when we ran the analysis. But suppose volatility turned out different from what the market expected? The possibility that volatility might be different following an extreme rate shock can not be dismissed.

For some background, MBS are characterized by negative vega, meaning that increased volatility reduces their value. This makes sense, because the MBS holder is implicitly "short" an option to the borrower, and options become more valuable with higher volatility. Of course, high volatility would also drive up the value of any swaptions (or other option-type derivatives) used to hedge MBS. However, unless an institution were 100% hedged, it would still have a net exposure to vega, thus warranting an extra cushion of capital.

Historically, interest rate volatility has been anything but constant. As Exhibit 46 below illustrates, the standard deviation of interest rate changes, measured on a rolling 24-month basis, has been anything but steady. That the volatility of financial markets is not constant, but rather shifts over time, clustering at high levels in certain periods, and at low levels in others, is at the heart of Mandelbrot's theory of fat tails. Exhibit 47 below shows some recent history for implied volatility, as discounted in the premiums of swaptions. Implied volatility represents the market's expectations about volatility, as implied in the premiums paid for swaptions and other kinds of interest rate options, although it can be distorted by technical shifts in the supply of and demand for these options. As a reminder, our analysis ignores fluctuations in option-adjusted spreads and implied volatility, as the cash flows for a hold-to-maturity investor would not necessarily be affected by changes in current market prices. But a change in actual volatility would theoretically impact expected cash flows to a hold-to-maturity investor, because of shifts in the probability of duration extension or contraction shocks.

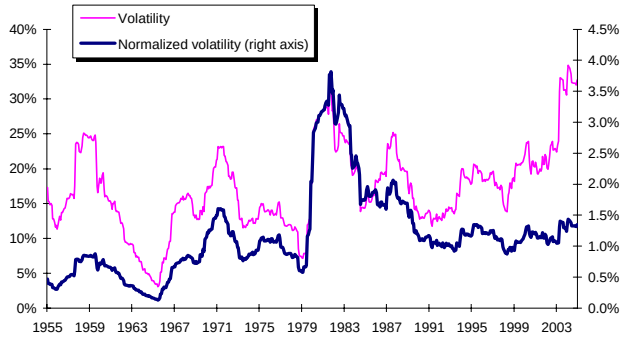
As an aside, interest rate volatility appears to have increased over the last 20 years. One possible explanation is monetary policy. During the tenures of Paul Volcker and Alan Greenspan, the Federal Reserve adjusted interest rates to fight both inflation and recession. In prior years, interest-rate stability was a more important goal for the Fed than it is today. Perhaps interest-rate volatility has been the price to pay for relative economic stability, whereas in previous periods, interest rates were more stable but economic growth less so.[71] As noted above, using historical distributions of interest rates to predict the future could be dangerous, because the volatility of past years has been, on average, lower than what is being experienced today.

[71] Peter Fortune, "An Assessment of Financial Market Volatility: Bills, Bonds, and Stocks," *New England Economic Review*, November/December 1989. Mark W. Watson, "Explaining the Increased Variability in Long-Term Interest Rates," Federal Reserve Bank of Richmond *Economic Quarterly* Volume 85/4, Fall 1999. Richard Clarida, Jordi Glai, Mark Gertler, "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory," *The Quarterly Journal of Economics*, February 2000.

Please see analyst certification and other important disclosures starting on page 58.

Exhibit 46

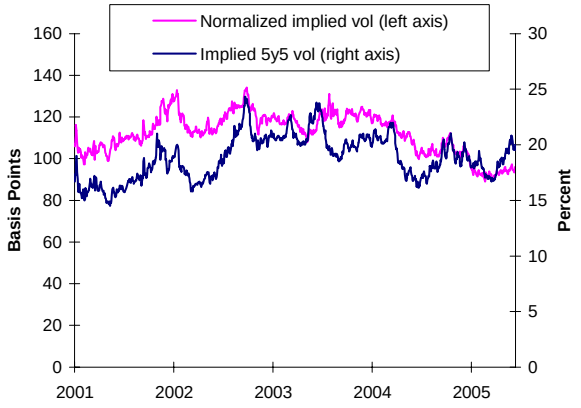
Historical Volatility of 10-year US Treasuries



Note: Volatility calculated as rolling 24 -month standard deviation of one-month changes in 10-year Treasury yield, annualized. Normalized volatility equals volatility multiplied by current 10-year Treasury yield.
Source: Federal Reserve, Morgan Stanley Research

Exhibit 47

Implied Volatility of Swaptions



Note: Normalized volatility equals implied volatility times the forward rate.
Source: Morgan Stanley Fixed Income Research

The prudent capital cushion for vega exposure depends in part on how much one thought volatility might shift. From the historical data noted above, we find that actual interest rate volatility has averaged 17% with a standard deviation of around 6% annually or 0.4% per month (yes, these are standard deviations of standard deviations). However, during the extreme interest rate shocks we have analyzed, volatility would be, by definition, rising well beyond normal levels. A regulated financial institution should hold capital not only against the possibility of a large interest rate shock, but also against the risk that that shock is ushering in an era of elevated volatility, in which one should expect more frequent and bigger shocks, all of which would render MBS less valuable than in the past. For the purposes of our analysis, we assume that a one standard deviation shock to volatility, conditional on an extreme interest rate shock having just occurred, would be around 12% on an annual basis, or 100 bps on a monthly basis. Under our economic capital model, a AAA-rated entity needs to withstand a four-standard deviation shock,[72] or a one-month increase in interest rate volatility of four percentage points; for the BB standard, we need only three standard deviations. Based on calculations performed by Applied Financial Technology, we estimate the vega of the MBS portfolio at around -7 bps. If we use swaptions to hedge 75% of this exposure, then we're left with a net vega exposure for the portfolio of -1.8 bps. Multiplying the net vega by the appropriate volatility shocks gives us the supplemental capital cushion appropriate for each targeted debt rating (Exhibit 48).

Exhibit 48

Capital Requirements for Vega Exposure

	Approximate Rating			
	AAA	AA/A	BBB	BB
Annual default rate (bps)	2.5	6	31	139
Implied monthly default rate (bps)	0.2	0.5	2.6	11.6
Scenario (of 50,000)	1	3	13	58
Standard Deviations	4.1	3.9	3.5	3.0
Net portfolio $ vega (mm)	-0.02	-0.02	-0.02	-0.02
Volatility shock (bps)	100	100	100	100
Scenario loss/ capital requirement for volatility shock	0.7%	0.7%	0.6%	0.6%

Note: assumes 75% convexity/vega hedged, approximately zero-month duration gap.
Source: Applied Financial Technology, Moody's, Morgan Stanley Research

[72] This assumes, for simplicity, that interest-rate volatility follows a normal distribution. The number of standard deviations corresponds to the monthly probabilities we assign to the different target debt ratings.

Model Risk

According to our analysis, model risk warrants a capital cushion of 1.6% for a AA/A-rated institution. The development of sophisticated financial modeling has been one of the driving forces in the management of risk and hence in the growth and efficiency of the financial markets. Today firms can use hedging techniques to mitigate risk exposures, rather than relying on large and expensive cushions of equity. However, to properly hedge, a firm must have a precise, quantitative assessment of its business risks. This requires the use of mathematical models that measure exposure accurately. As Nobel laureate Robert Merton points out:

> Any virtue can become a vice if taken to extreme…the mathematics of models are precise, but the models are not, being only approximations to the complex, real world. Their accuracy as a useful approximation to that world varies considerably across time and place. The practitioner should therefore apply the models only tentatively, assessing their limitations carefully in each application.[73]

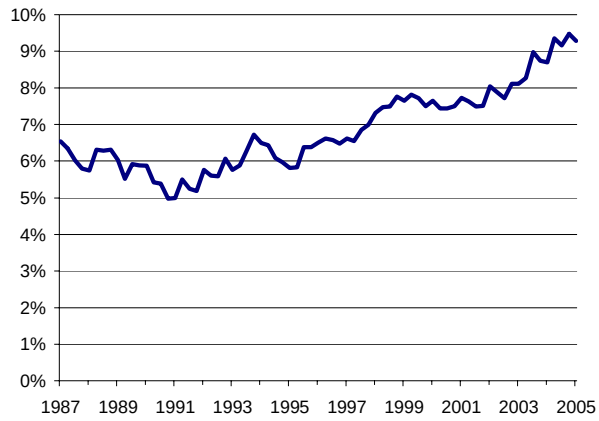
The calculations in the preceding sections assume that our analysis of MBS value under extreme rate shock scenarios is precisely accurate; if not, our hedging calculations could be thrown off, perhaps seriously. This is no trivial concern, because MBS values depend on assumptions about prepayment speeds, and no model can perfectly predict consumer behavior. Regulatory capital guidelines do not mandate formulae for capturing model risk, but they encourage regulators and bank managers to consider extreme scenarios where "key business assumptions and parameters break down."[74]

The primary source of model risk for valuing MBS, in our view, is the assumptions made about prepayment speeds. There are two components to these assumptions: housing turnover and the sensitivity of refinancings to interest rate changes.

MBS values are sensitive to assumptions about the housing market. Just to drive home this point, consider a chart of housing turnover, defined as the ratio of new and existing home sales to the total stock of housing units (Exhibit 49). Housing turnover has steadily increased over the last fifteen years. To what extent does this turnover rate reflect changes to tax laws, rising home prices, loosened underwriting standards, new mortgage products, low interest rates, or demographic changes? There is no conclusive answer. Similarly, MBS models do not perfectly predict how prepayment speeds shift with interest rates. Competition among mortgage lenders, improvements in their technology, and the development of new products can affect the prices offered consumers and hence their incentives to refinance. Further, consumer behavior changes with experience and education and under the influence of the media. It would be unrealistic to expect models to capture all of these trends.

Exhibit 49

Housing Turnover Is a Key Assumption in MBS Valuation



Note: Housing stock turnover calculated as new and existing home sales divided by the total stock of single-family units.
Source: U.S. Census Bureau, National Association of Realtors

To assess the extra capital necessary to guard against model risk, we asked Applied Financial Technology to estimate a one standard deviation shock for model risk. Their estimate reflects a judgment about the volatility of security prices when the market is confronting turbulent interest rates and rethinking expectations about housing turnover and refinancing sensitivities (see sidebar below). Their conclusion is that a one standard deviation shock is equivalent to about a 10% shift in housing turnover, for example, from a base case assumption of 9% to 8.1% or

[73] Robert C. Merton, "Influence of mathematical models in finance on practice: past, present and future," *Philosophical Transactions of the Royal Society of London*, Volume 347, Number 1684, 15 June 1994, pp. 459-461.
[74] Basel Committee on Banking Supervision, *Principles for the Management and Supervision of Interest Rate Risk*, Bank for International Settlements, July 2004, p. 17.

9.9%. Put differently, if one assumes annual home sales of 6.8 million units, then a one standard deviation risk would be 680,000 units. This degree of variability has a modest effect on MBS values, which would lose or gain about 5 bps (Exhibit 50). The refinancing component of prepayment speeds has a larger effect on MBS values. Freddie Mac tells us that it considers model risk in its economic capital calculations. To estimate model risk, the company tracks the performance of its prepayment models on a monthly basis and compares their predictions to models run by broker-dealers and consultants.

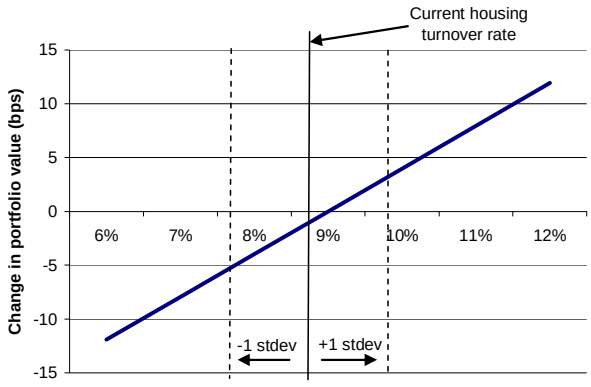
Applied Financial Technology on Model Risk

Valuation of MBS is dependent on the long-term connection between mortgage rates and resulting prepayment response. More precisely, their market values are dependent on the assumption of what the connection is. MBS prices often fluctuate as these assumptions go through periods of revaluation. Even prices calculated using a perfect prepayment model would not correspond to market prices during these periods. In order to get a ball-park estimate of price volatility due to prepayments, one needs to not only make an estimate of the expected model long-term errors, but also of the expected changes in market assumptions. Fairly dramatic revaluations happen when interest rates reach new extremes. Often times, these revaluations are nowhere near what would be considered reasonable under cooler conditions (the so called "market gone crazy" periods.)

It is very difficult to give a precise estimate of both the extent of one-sigma market assumption fluctuations, and of the model long-term expected errors. One way to do that, is to consider historically what multiplier to the AFT standard prepayment model would make IOs and POs have the same option-adjusted spread ("break-even" multiplier). We have seen the multiplier fluctuate between about 0.7 and 1.3 for premium collateral, and between 0.85 and 1.2 for current coupon/discount collateral. These changes take place over several months as interest rates move to their extremes and "unexpected" prepayments take place. Under instantaneous shock assumptions, it would be prudent to presume that these assumptions change with interest rates (in reality it may take a couple of months for prepayments to become observable, leading to revaluation.) Thus, a reasonable value for a one-sigma shock to refinancing assumptions is 15% and to housing turnover assumptions is 10% (for the refinancing component, the break-even multipliers of .7 to 1.3 are the extremes; about half of the time half of the collateral will have the break-even multiplier of 0.85 to 1.15, with the same logic for the housing turnover component).

Exhibit 50

Sensitivity of MBS Portfolio to Housing Turnover Assumption



Source: Applied Financial Technology, Morgan Stanley Research

Applied Financial Technology provided us with the sensitivity of MBS values to model risk for each of our scenarios, allowing us to calculate the appropriate capital cushion. As with vega risk, institutions targeting higher debt ratings should hold capital against a higher number of standard deviations of model risk (Exhibit 51).

Exhibit 51

Capital Requirements for Model Risk

	Approximate Rating			
	AAA	AA/A	BBB	BB
Annualized (bps)	2.5	6	31	139
Implied monthly (bps)	0.2	0.5	2.6	11.6
Scenario (of 50,000)	1	3	13	58
Standard deviations	4.1	3.9	3.5	3.0
1 standard deviation shock	0.5%	0.4%	0.3%	0.3%
Scenario loss / capital requirement for model risk	2.0%	1.6%	1.0%	0.9%

Note: Assumes refi and housing turnover risk are uncorrelated. Both risks are combined by taking the square-root of the sum of squares.

Source: APPLIED FINANCIAL TECHNOLOGY, Morgan Stanley Research

Short-term Debt and Basis Risk

Our capital calculations include 30 bps as a cushion against basis risk from the heavy use of short-term debt. Basis risk refers to possible changes in the relationship between mortgage spreads and the GSEs' funding costs. In a shock scenario, if the market became concerned about the GSEs' capital base and creditworthiness, then the spreads required to roll over their short term debt might widen. Higher funding costs would immediately cut into the net interest margin, negatively impacting economic capital, and possibly compounding the effect of any losses incurred from the interest rate shock itself. While this scenario might seem far-fetched, given the GSEs' strong liquidity and the perception of a tight government relationship, it is worth recalling that Fannie's debt spreads widened in 2002 merely on the disclosure of an unusually wide duration gap.

Just to be clear, basis risk is different than duration risk. A firm could swap its short-term debt out to the same maturity as its MBS, thus eliminating duration risk. But it would still be sensitive to changes in short-term funding spreads as that debt rolled over, and the swap would not mitigate that risk, because its terms are contractually fixed. Basis risk could arise from any factor that affected debt investors' appetite for short term paper, not just interest rate shocks, for example macro-economic trends, political and regulatory issues, and volumes of issuance.

At present, Fannie and Freddie use much more short-term, unsecured debt than major banks and broker dealers. If Fannie and Freddie were truly private companies, an argument could be made that their use of short-term debt was imprudent. In an extreme rate scenario, if the market really became worried about a firm's financial condition, its debt spreads might widen out substantially further than the 80 bps we used in our analysis. As such, we expect a new regulator to require the GSEs to reduce their reliance on short-term debt. In fact, Freddie Mac tells us that it has already decided to reduce its use of short-term debt.

The GSEs' exposure to short-term debt dwarfs that of other major financial institutions. At year-end 2004, short-term unsecured debt accounted for 39% of Freddie's total liabilities; for Fannie, the ratio at 2Q04 (the most recent disclosure) was 45% (Exhibit 52). In comparison, the ratio for GE was 25%, and for the other major financial institutions we view as comparables, including banks, thrifts, and broker-dealers, the ratio was under 10%. Of note, this ratio includes only *unsecured* borrowings, as the spread on secured borrowings should be relatively insensitive to the firm's financial health, provided that the collateral underlying the secured loans is still good. Also, we exclude short-term or core deposits, because the government guarantees the lion's share of these liabilities. But the GSEs' exposure to short-term debt is more severe than these ratios suggest, because of their comparatively higher leverage. At year-end 2004, the ratio of short-term debt to shareholders' equity at Freddie was 902%; for Fannie Mae at 2Q04, the ratio was even higher at 1625%. In contrast, for all other issuers, the ratios were below 200%.

Theoretically speaking, heavy usage of short-term debt may be appropriate because it subjects borrowers to capital markets discipline. For a firm with high levels of short-term debt, imprudent risk-taking, if detected by public debt holders, should lead immediately to higher financing costs and may result in the firm being cut off from the supply of new capital. A levered firm that must roll over short- term debt has effectively given the market an option to shut it down before it can exhaust its capital, thus minimizing the risk of looting or "gambling for resurrection" if it gets into trouble.[75] In contrast, a firm that has locked in its funding with long-term commitments is immune to capital markets discipline, at least until its debt matures. The GSEs and other major financial firms that employ short-term debt cannot afford to fall out of favor with capital markets investors. Perhaps this is a good thing.

[75] Mark J. Flannery, "Debt Maturity and the Deadweight Cost of Leverage: Optimally Financing Banking Firms," *The American Economic Review*, Vol. 84, No. 1, March 1994. Also, Douglas W. Diamond, "Debt Maturity Structure and Liquidity Risk," *The Quarterly Journal of Economics*, August 1991.

Please see analyst certification and other important disclosures starting on page 58.

Exhibit 52

Short Term Debt as % of Total Liabilities

$ mm	ST Unsecured Borrowings	LT Unsecured Borrowings	Total Unsecured Borrowings	ST Borrowings / Total Borrowings	Deposit	Total Liabilities	Equity	ST Debt / Total Liabilities	ST Unsecured Debt/Equity
Fannie Mae	424,372	515,296	939,668	45.2%		963,220	26,121	44%	1625%
Freddie Mac	282,303	449,394	731,697	38.6%		762,359	31,306	37%	902%
General Electric	156,769	212,928	369,697	42.4%		620,763	112,872	25%	139%
Goldman Sachs	48,854	95,577	144,431	33.8%		570,074	26,075	9%	187%
Bank of America	93,440	98,763	192,203	48.6%	629,987	1,113,720	98,519	8%	95%
Wells Fargo	24,451	76,903	101,354	24.1%	273,163	397,166	38,477	6%	64%
Bear Stearns	15,168	38,972	54,140	28.0%		258,911	9,518	6%	159%
Morgan Stanley	30,792	104,350	135,142	22.8%	13,950	773,715	28,495	4%	108%
Golden West	2,486	45,518	48,004	5.2%	55,593	105,008	7,579	2%	33%
Citigroup	32,271	207,935	240,206	13.4%	568,874	1,379,355	110,536	2%	29%
J.P. Morgan	13,063	99,329	112,392	11.6%	531,379	1,072,965	105,340	1%	12%
Lehman Brothers	3,079	59,366	62,445	4.9%		347,938	15,754	1%	20%

ST = Short term, LT = Long term

Note: Fannie Mae data as of 2Q04; Freddie Mac data as of 4Q04; all others as of 1Q05.

Source: Company disclosures, Morgan Stanley Research

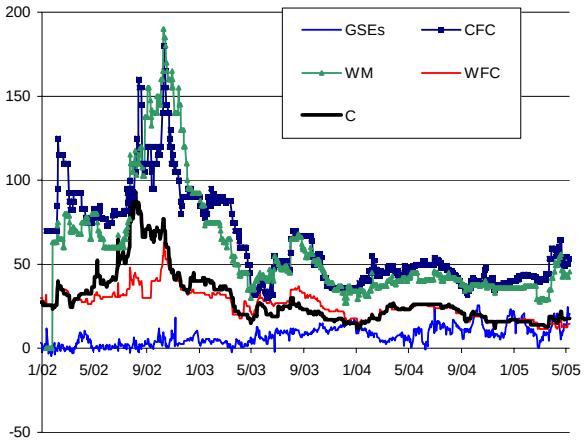
Another explanation would be that short-term debt is cheaper. As of this writing, the all-in cost to Fannie and Freddie of issuing short-term debt swapped out to a five-year term was only 2 bps less than the cost of issuing five-year bullet debt. This hardly seems enough savings to take on massive basis risk. However, it may be the debt markets have greater appetite for short-term GSE debt than for long-term. The GSEs may have issued short and long-term debt in proportion to investor appetite and thus equalized costs at the margin, even if the resulting mix of maturities left them overexposed on the short side. If they issued more long-term debt, their borrowing costs might be higher.

High levels of short-term debt can leave firms vulnerable to predatory trading. When a large investor in financial distress is forced to unwind its position (a time when it desperately needs liquidity), then other traders may initially trade in the same direction, i.e., they may withdraw liquidity instead of providing it. This strategic behavior could force the distressed investor to liquidate its portfolio at firesale prices, providing a bargain for traders operating opportunistically. Predatory trading may have contributed to the demise of LTCM in the fall of 1998.[76] In the colorful words of Nassim Taleb, "Find me a dynamic hedger who is a reluctant liquidator and I will front run him to near bankruptcy."[77] Without government backing, the GSEs might be vulnerable to predatory trading, if investors thought an extreme rate shock had imperiled their capital. In a nervous market, opportunistic traders might pull back from providing short-term funding or the swap transactions necessary for the GSEs to rebalance their portfolios.

Over the last five years, short-term debt spreads for financial institutions have proven volatile. Exhibit 53 contrasts the spreads to treasuries for 3-month debt issued by the GSEs and a collection of other financial institutions over the past five years. Exhibit 54 shows the average and one-month standard deviation of their spreads over this time period. For the GSEs, both the average spread and the standard deviation have been lower than their peers, possibly reflecting the perception of implicit backing by the government or possibly their comparatively low credit losses during a difficult stretch in the economy.

Exhibit 53

Financial Institutions Spreads on 3-month Debt, 2002-Present



Note: Spreads over 3-month Treasuries. Source: Morgan Stanley Fixed Income Research

[76] Markus Brunnermeier, Lasse Heje Pedersen, "Predatory Trading," *National Bureau of Economic Research*, Working Paper 10755, September 2004, p. 2.

[77] *Derivatives Strategy*, p. 3.

Exhibit 54

Standard Deviation of Financial Institutions Spreads on 3-month Debt Over Treasuries, 2001-2004

Issuer	Rating	Average Spread	Stdev of Spread
GSEs / Agencies	AAA	7	6
Countrywide	A	63	27
Washington Mutual	A	59	32
Goldman Sachs	A	49	21
Lehman Brothers	A	45	18
JP Morgan	A	44	22
Bear Stearns	A	49	24
Wells Fargo	AA	28	11
Citigroup	AA	29	15

Source: Morgan Stanley Fixed Income Research

Even modest spread widening would impact the economic value of the GSEs' retained portfolios. Let's take the average one-month standard deviation of short-term funding spreads for the issuers listed above, namely 20 bps. According to our methodology, for the AAA standard, we would look for enough capital to withstand a four standard-deviation shock, i.e., 80 bps of spread widening, while for the BB, three standard deviations suffice.[78] For that portion of borrowings accounted for by short-term debt, which we assume to be 40%, we multiply the spread shock by the expected remaining duration of the MBS portfolio in the wake of the shock, which we assume is around three years.[79] This calculation gives us the economic loss associated with an increase in funding costs and hence the capital cushion necessary to guard against it.

As a postscript, this calculation might be considered generous. In the extreme rate shock scenarios we model, where an economic loss of 3% of assets would be conceivable, a GSE might suffer a significant depletion of its capital, leaving it in precarious condition. For a truly private company caught in this stressful situation, one could imagine spreads widening by substantially more than 20 or 80 bps.

Exhibit 55

Capital Requirements for Basis Risk

	Approximate Rating			
	AAA	AA/A	BBB	BB
Annual default rate (bps)	2.5	6	31	139
Implied monthly default rate (bps)	0.2	0.5	2.6	11.6
Scenario (of 50,000)	1	3	13	58
Standard deviations	4.1	3.9	3.5	3.0
Average life of the MBS assets (yrs)	3.0	3.0	3.0	3.0
Credit spread shock (bps)	20	20	20	20
Scenario loss / capital requirement for credit shock with % of st debt =				
20%	0.5%	0.5%	0.4%	0.4%
30%	0.7%	0.7%	0.6%	0.5%
40%	1.0%	0.9%	0.8%	0.7%

st = short term

Source: Morgan Stanley Research

[78] This methodology assumes the normal distribution.

[79] In fact, depending on the direction of the interest rate shock, the MBS duration could range from 7 to 63 months. Three years is an approximate average.

Please see analyst certification and other important disclosures starting on page 58.

Swap Market Liquidity

Our capital estimates include a supplemental cushion of roughly 0.4% to protect against the risk of illiquidity in the swap markets. Regulatory capital guidelines mention liquidity risk in passing, although they do not mandate a methodology for assessing supplemental capital. Some researchers have taken a stab at quantifying liquidity risk. For example, one study estimated that for portfolios concentrated in emerging markets, capital should be set 25-30% higher than what a simple value-at-risk model would require because of poor liquidity.[80]

For the GSEs, we are not concerned about the liquidity of the MBS market, given the enormous size of the market, the standardization of the securities, and their low credit risk. But the GSEs need to continually rebalance the duration of their portfolios; this means they could be vulnerable to disruptions in the derivatives markets, especially if a severe interest rate shock led to a massive demand for liquidity on the part of mortgage originators, mortgage servicers, and other investors all at once.[81] The need to rebalance at distorted swap market prices could result in economic losses for the GSEs and others.

Dynamic hedging is endemic in the mortgage and derivatives markets. The "negative convexity" profile of mortgages means that changing interest rates influence the prepayment behaviors of the underlying borrowers. As interest rates fall, borrowers start refinancing, and the expected life of mortgage securities falls; with rising rates, the opposite effect happens. For many participants in the market, the changing durations of MBS requires them to adjust the duration of their liabilities, and this they typically do through interest-rate swaps, as we mentioned above. Other participants purchase options to protect them from the need to rebalance. But this just shifts the need for rebalancing to the dealer that provided the option.[82] And as we pointed out above, twists in the yield curve or incorrect model assumptions can complicate hedging, so that even those participants that purchased options in advance may still find they need to rebalance.

Concerns over dynamic hedging in financial markets date back to the 1987 stock market crash, if not before. Government studies blamed the crash on the spread of "portfolio insurance," a practice adopted by certain institutional investors of attempting to limit losses by dumping shares as markets sold off. Fischer Black argued that the crash was in fact triggered by the dawning realization that the spread of portfolio insurance signaled an overly aggressive attitude among market participants toward risk.[83] Some academics downplayed portfolio insurance as a cause of the crash, noting that portfolio insurance trades accounted for a modest share of total volumes and pointing out that international stock markets collapsed, too, without portfolio insurance.[84] Others have pointed out that, once the market becomes aware of the magnitude of the demand for hedging, the impact on prices from actual trades should be minimal.[85] Nonetheless, concerns have echoed down through the years, especially in markets, like the mortgage market, where dynamic hedging is commonly practiced.

As an aside, Greenspan has singled out the GSEs as major contributors to potential swap market liquidity issues. He warns that "concerns about potential disruptions to swaps market liquidity will remain valid until the vast leveraged portfolios of mortgage assets held by Fannie and Freddie are reduced and the associated concentrations of market risk and risk-management responsibilities are correspondingly diminished."[86] His concerns stem, in part from the reliance of the GSEs on around 20 dealers in options, only five or six of which have direct access to the supply of options. If one of these

[80] Anil Bangia, Francis X. Diebold, Til Schuermann, John D. Stroughair, "Modeling Liquidity Risk," December 21, 1998.
[81] For information on hedging demands for each segment of the mortgage market, see Laurie S. Goodman, Jeffrey Ho, "Measuring the Mortgage Market's Convexity Needs," *The Journal of Fixed Income*, September 2004.
[82] Kambhu and Mosser argue that option dealer rebalancing in the wake of an interest rate shock is sizeable enough to affect the shape of the yield curve, and the Federal Reserve staff study cited above suggests that dealer rebalancing can take several months.
[83] "An Equilibrium Model of the Crash," in *NBER Macroeconomics Annual*, edited by Stanley Fischer, The MIT Press, Cambridge, MA, 1988.
[84] Richard Roll, "The International Crash of 1987," in *Black Monday and the Future of Financial Markets*, pp 35-70.
[85] Sanford J. Grossman, "An Analysis of the Implications for Stock and Futures Price Volatility of Program Trading and Dynamic Hedging Strategies," *Journal of Business*, vol. 61, no. 3, 1988. Michael J. Brennan and Eduardo S. Schwartz, "Portfolio Insurance and Financial Market Equilibrium," *Journal of Business*, vol. 62, no. 4, 1989. Gerard Gennotte and Hayne Leland, "Market Liquidity, Hedging, and Crashes," *The American Economic Review*, December 1990.
[86] Remarks by Chairman Alan Greenspan, "Risk Transfer and Financial Stability," at the Federal Reserve Bank of Chicago's Forty-first Annual Conference on Bank Structure, May 5, 2005, p. 3.

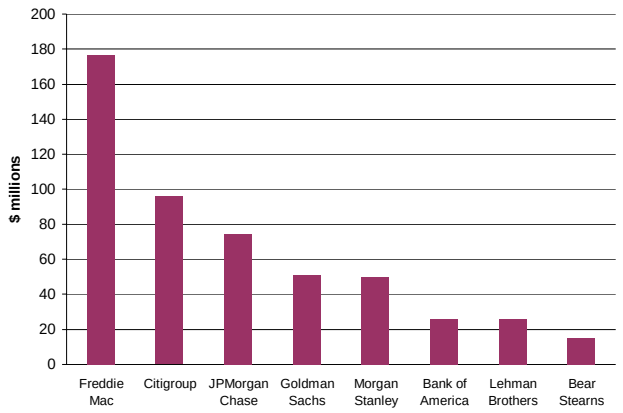
Please see analyst certification and other important disclosures starting on page 58.

dealers failed, then the GSEs would presumably be forced to depend on the swap markets even more heavily.

The GSEs' relative size in the market can be seen by comparing value-at-risk measures. Similar to the manner in which we extrapolated from Freddie Mac's PMVS disclosure to a capital standard, we can also transform the metric into a one-day 99% value-at-risk metric.[87] Exhibit 56 shows that our estimate of Freddie Mac's one-day 99% value-at-risk is almost double the fixed-income value-at-risk for the next highest firm, Citigroup, and substantially higher than that of other major banks and broker-dealers. This comparison may understate the difference, because the other firms' disclosures would likely include fixed-income credit risk, as well as interest-rate risk, whereas Freddie' does not include credit risk.

Exhibit 56

One-day 99% Value-at-Risk for Freddie Mac and Major Banks and Brokers



Note: Year-end 2004.

Freddie Mac value-at-risk based on Morgan Stanley estimates. Measures for other firms refer to fixed-income value-at-risk. Goldman Sachs figure scaled from 95% disclosure.

Source: Company disclosures, Morgan Stanley Research

We see some logic in Greenspan's concern. In our previous study, we estimated that a 200-bp interest rate shock would create a $2.6 trillion duration-dollar rebalancing requirement for Fannie and Freddie, equivalent to something like 5% of the dollar-duration of the entire US fixed-income market. In this environment, we reasoned that it might take several weeks for the GSEs to rebalance.[88]

The evidence supports the idea that big interest rate shocks can lead to widening of swap market spreads

In a 2002 speech, Federal Reserve Vice Chairman Roger Ferguson, Jr. addressed the issue of mortgage prepayments and financial volatility. Ferguson acknowledged that mortgage risk management activities are "large enough to have an effect on the underlying fixed-income markets," but he claimed the effect is "small and dissipates relatively quickly." He cited Federal Reserve research that found minor impacts on treasury rates that lasted no longer than six weeks and amounted to no more than 25 bps, even in the aftermath of the market disruption surrounding the terrorist attacks of 9/11.[89] Nonetheless, 25 bps is enough to create economic losses, as we discuss below.

A more recent paper by Federal Reserve economists Roberto Perli and Brian Sack found that mortgage hedging activities could lead to a 16-28% amplification of swap market volatility; what this means is that a 50-bp shock to interest rates might lead swap rates to widen by 8 to 14 bps more than they would have otherwise and persist for several months.[90] For the 200-bp shock scenarios we are considering, such amplification could have serious consequences.

A draft article by Freddie Mac economists challenges the Fed researchers' analysis, pointing out that most of the link between mortgage hedging and interest-rate volatility is "an artifact of several outlier observations in the data," such as the LTCM crisis and 9/11.[91] Even so, these outliers remind us that the vulnerability exists, if only for severe, infrequent shocks.

During the summer of 2003, a 100-bp rise in interest rates may again have led to major mortgage hedging demands. To the casual observer, it certainly looked like

[87] In this case, the metric is multiplied by 1.41 to convert from a 95% probability to 99% and divided by the square root of 20 to convert from a monthly to daily statistic. We then multiply the daily statistic by the size of Freddie's retained portfolio.

[88] *Fannie Mae, Freddie Mac, and Interest Rate Risk*, Morgan Stanley Research, September 9, 2002, pp. 36-37.

[89] Federal Reserve Board, Remarks by Vice Chairman Roger W. Ferguson, Jr., At the Annual Conference on the Securities Industry, American Institute of Certified Public Accountants and the Financial Management Division of the Securities Industry Association, New York, November 20, 2002.

[90] Roberto Perli, Brian Sack, "Does Mortgage Hedging Amplify Movements in Long-Term Interest Rates," *The Journal of Fixed Income*, December 2003.

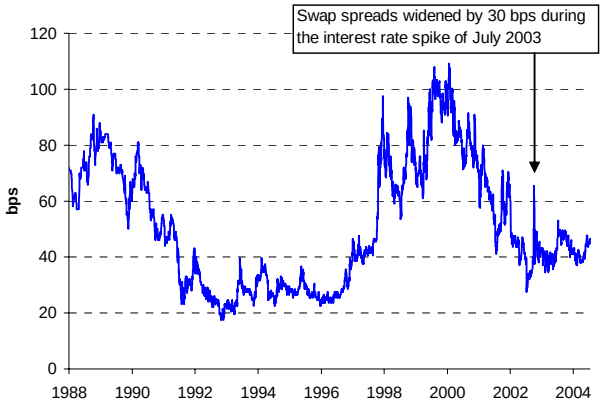
[91] Yan Chang, Douglas McManus, Buchi Ramagopal, "Does Mortgage Hedging Raise Long-Term Interest Rate Volatility," Freddie Mac Office of the Chief Economist, September 2004.

Please see analyst certification and other important disclosures starting on page 58.

the gap in swap spreads during that period might have been correlated with a sharp extension in MBS duration.[92] A Bank of England study estimated the impact on swap market spreads from mortgage refinancing activity was approximately 20 bps.[93] A study by staff of the Federal Reserve concluded that unfavorable prices in the options markets, where dealers were struggling to rebalance their own books, forced the GSEs and other mortgage convexity hedgers to increase their trading in the swaps market, and this activity contributed to reduced liquidity and wider spreads in the swaps market during that time.[94]

Exhibit 57

Swap Spreads Can Be Volatile



Note: 5-year swap spreads to treasuries

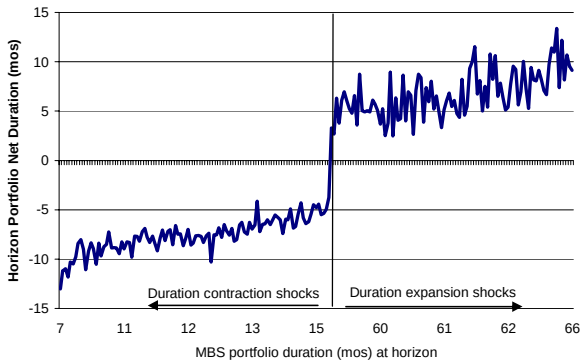
Source: Morgan Stanley Fixed Income Research

For the GSEs, rebalancing is an imperative, no matter what the condition of the swap market. Our previous calculations made clear that, as the duration gap moves away from zero, the risk profile for the institution increases, requiring added capital. Further, Fannie and Freddie have articulated policies under which they limit their duration gaps to targeted bands, and since they disclose the gap each month, failure to abide by the policy could spark market concerns. Finally, their regulator might use an extended duration gap as a basis for prompt corrective action. As such, in the aftermath of an extreme rate shock, even if the swap market is illiquid, the GSEs must rebalance, and that may mean paying high prices to do so and thus incurring economic losses on top of whatever may have been suffered as a result of the interest rate shock itself.

To figure the capital cushion for this risk, we look first at where the duration gap for the portfolio is likely to end up in the wake of an extreme rate shock. Exhibit 58 shows that the duration might fall as low as seven months or extend as high as 66 months after the worst shocks in our two hundred interest rate scenarios. We then assume, based on the various studies noted above, as well as conversations with colleagues in fixed-income research, that a one standard deviation shock to swap market spreads is about 10 bps.[95] The economic cost to rebalancing during an illiquid swap market is the abnormal swap spread multiplied by the number of months by which the duration gap needs to be reduced or extended to rebalance the portfolio net gap to zero. Exhibit 59 shows the resulting capital requirements by target debt rating.

Exhibit 58

Portfolio ending duration gap after one-month shock



Note: portfolio starts month with duration gap of approximately zero months and 75% convexity hedging.

[92] According to the Salomon MBS Index, the duration of securitized mortgages extended from 22 monhts in early July to as high as 50 months in early August.

[93] Fabio Cortes, "Understanding and modeling swap spreads," *Bank of England Quarterly Bulletin*: Winter 2003, pp. 411-413.

[94] Staff of the Board of Governors of the Federal Reserve Systems and the Federal Reserve Bank of New York, "Concentration Risk in the OTC Markets for U.S. Dollar Interest Rate Options," March 2005, p. 5.

[95] To be clear, our analysis considers this widening in swap spreads to be a form of transaction cost, like the widening of a bid-ask spread. Otherwise, as noted above, our methodology for valuing MBS and derivatives in extreme interest rate shock scenarios assumes that all spreads are constant.

Please see analyst certification and other important disclosures starting on page 58.

Exhibit 59

Liquidity Risk

	Approximate Rating			
	AAA	AA/A	BBB	BB
Annual default rate (bps)	2.5	6	31	139
Implied monthly default rate (bps)	0.2	0.5	2.6	11.6
Scenario (of 50,000)	1	3	13	58
Standard deviations	4.1	3.9	3.5	3.0
Duration of the portfolio at t+1	1.1	1.0	0.9	0.8
Swap spread shock (bps)	10	10	10	10
Scenario loss / capital requirement for swap liquidity	0.4%	0.4%	0.3%	0.2%

Source: APPLIED FINANCIAL TECHNOLOGY, Morgan Stanley Research.

Please see analyst certification and other important disclosures starting on page 58.

Appendix A: FNM Segment Data and Valuation

	2003	2004E	2005E	2006E	2007E	2008E	2009E
Assumptions							
NIM (%) (1)	1.20%	1.00%	0.90%	0.80%	0.67%	0.67%	0.67%
G-fees (bps)	20.3	20.6	20.0	20.5	20.5	20.5	20.5
Credit Guarantee - SGA/Total Book (bps)		5.0	5.0	5.0	5.0	5.0	5.0
Retained Portfolio - SGA/Retained Portfolio (bps)		5.1	5.1	5.1	5.1	5.1	5.1
NCO / Avg. Total Book (bps)	0.0	0.4	0.9	1.5	2.0	2.3	2.5
REO / Total Book of Business (bps)	0.0	0.3	0.3	0.4	0.5	0.5	0.5
Tax rate - Credit Guarantee (%)	19.8%	19.8%	25.0%	25.0%	25.0%	25.0%	25.0%
Tax rate - Retained Portfolio (%)	28.2%	28.2%	28.2%	28.2%	28.2%	28.2%	28.2%
MBS Outstanding - growth (%)	26.3%	7.9%	8.0%	7.0%	7.0%	7.0%	7.0%
Retained Portfolio - growth (%)	13.1%	0.3%	-10.0%	0.0%	0.0%	0.0%	0.0%
Common Equity / Total Equity	81.6%	70.8%	75.2%	80.0%	80.0%	80.0%	80.0%
Preferred Dividend Rate (%)		5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
Avg. Retained Portfolio ($ mm)	839,090	888,936	836,159	814,100	814,100	814,100	814,100
Avg. Net MBS Outstanding ($ mm)	1,180,218	1,358,770	1,467,577	1,568,006	1,677,767	1,795,210	1,920,875
Avg. Total Book of Business ($ mm)	2,027,761	2,253,310	2,303,736	2,382,106	2,491,866	2,609,310	2,734,975
Credit Guarantee							
Guarantee Fees on Net MBS	2,390	2,802	2,935	3,214	3,439	3,680	3,938
Guarantee Fees from Retained Business	1,667	1,833	1,672	1,669	1,669	1,669	1,669
Net Interest Income	803	1,127	1,152	1,191	1,246	1,305	1,367
Other Income	(58)	(76)	-	-	-	-	-
SGA	1,034	1,127	1,152	1,191	1,246	1,305	1,367
Loss Provision + REO	112	172	291	488	673	776	889
Pre-Tax Income	3,656	4,388	4,317	4,395	4,436	4,573	4,718
Taxes	729	869	1,079	1,099	1,109	1,143	1,179
Operating Income	2,927	3,519	3,237	3,296	3,327	3,430	3,538
Less Preferred Dividends		(175)	(145)	(150)	(157)	(126)	(132)
Operating Income Available to Common		3,344	3,093	3,146	3,170	3,303	3,406
Avg. Net MBS Outstanding	1,180,218	1,358,770	1,467,577	1,568,006	1,677,767	1,795,210	1,920,875
Avg. Total Book of Business	2,027,761	2,253,310	2,303,736	2,382,106	2,491,866	2,609,310	2,734,975
Capital Requirement	0.45%	0.45%	0.45%	0.45%	0.45%	0.45%	0.45%
Required Capital	9,125	10,140	10,367	10,719	11,213	11,742	12,307
plus surplus		2,687	3,110	3,216	3,364	-	-
Total Capital	9,125	12,827	13,477	13,935	14,577	11,742	12,307
Capital Ratio		0.57%	0.59%	0.59%	0.59%	0.45%	0.45%
Preferred Equity		3,258	2,695	2,787	2,915	2,348	2,461
Common Equity		9,569	10,781	11,148	11,662	9,394	9,846
ROE - Total Capital	32.1%	27.4%	24.0%	23.7%	22.8%	29.2%	28.8%
ROE - Common Equity		34.9%	28.7%	28.2%	27.2%	35.2%	34.6%

Operating Profitability Metrics & Other Key Statistics

	2004E	2005E	2006E	2007E	2008E	2009E
As a % of Avg. Book of Business						
Net Interest Income	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%
Guarantee Fees on Net MBS	0.12%	0.13%	0.13%	0.14%	0.14%	0.14%
Guarantee Fees from Retained Business	0.08%	0.07%	0.07%	0.07%	0.06%	0.06%
Total G-fees	0.21%	0.20%	0.21%	0.21%	0.21%	0.21%
Other Income	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
SGA	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%
Loss Provision	0.01%	0.01%	0.02%	0.03%	0.03%	0.03%
Pretax Income	0.19%	0.19%	0.18%	0.18%	0.18%	0.17%
Tax	0.04%	0.05%	0.05%	0.04%	0.04%	0.04%
After-tax Income	0.16%	0.14%	0.14%	0.13%	0.13%	0.13%
Operating Return on Avg. Assets	0.15%	0.13%	0.13%	0.13%	0.13%	0.12%
Operating Return on Avg. Common Equity	34.95%	28.68%	28.22%	27.18%	35.17%	34.59%
Common Equity / Avg. Book of Business	0.42%	0.47%	0.47%	0.47%	0.36%	0.36%

(1) Assumes FNM's NIM, net of G-fees falls due to poor performance in 2003 of fair value of equity

Source: Company data, Morgan Stanley Research estimates

Retained Portfolio - New Regime - FNM

Assumptions	**2003**	**2004E**	**2005E**	**2006E**	**2007E**	**2008E**	**2009E**
NIM (%)	1.20%	1.00%	0.90%	0.80%	0.67%	0.67%	0.67%
G-fees (bps)	20.3	20.6	20.0	20.5	20.5	20.5	20.5
Retained Portfolio - SGA/Retained Portfolio (bps)		5.1	5.1	5.1	5.1	5.1	5.1
NCO/Avg. Net Portfolio (bps)	0.0	0.4	0.9	1.5	2.0	2.3	2.5
REO / Total Book of Business (bps)	0.0	0.3	0.3	0.4	0.5	0.5	0.5
Tax rate - Retained Portfolio (%)	28.2%	28.2%	28.2%	28.2%	28.2%	28.2%	28.2%
Retained Portfolio - growth (%)	13.1%	0.3%	-10.0%	0.0%	0.0%	0.0%	0.0%
Net Interest Income (2)		10,805	9,079	7,708	6,270	6,229	6,186
Purch Options Amort.		-	-	-	-	-	-
Guarantee Fee Income/(expense) (1)		(1,833)	(1,672)	(1,669)	(1,669)	(1,669)	(1,669)
Other Income		-	-	-	-	-	-
SGA		453	426	415	415	415	415
Pre-Tax Income		8,518	6,980	5,624	4,185	4,145	4,102
Taxes		2,404	1,968	1,586	1,180	1,169	1,157
Operating Income		6,114	5,012	4,038	3,005	2,976	2,945
Less Preferred Dividends		(315)	(240)	(233)	(365)	(365)	(365)
Operating Income Available to Common		5,799	4,772	3,805	2,640	2,611	2,580
Avg. Retained Portfolio ($ mm)		888,936	836,159	814,100	814,100	814,100	814,100
Avg. Total Book of Business ($ mm)		2,253,310	2,303,736	2,382,106	2,491,866	2,609,310	2,734,975
Capital Requirement		2.05%	2.05%	2.05%	4.05%	4.05%	4.05%
Required Capital		18,223	17,141	16,689	32,971	32,971	32,971
plus surplus		4,829	5,142	5,007	1,000	1,000	1,000
Total Capital		23,052	22,284	21,696	33,971	33,971	33,971
Capital Ratio		2.59%	2.67%	2.67%	4.17%	4.17%	4.17%
Preferred Equity		5,855	4,457	4,339	6,794	6,794	6,794
Common Equity		17,197	17,827	17,357	27,177	27,177	27,177
ROE - Total Capital		26.5%	22.5%	18.6%	8.8%	8.8%	8.7%
ROE - Common Equity		33.7%	26.8%	21.9%	9.7%	9.6%	9.5%
Combined Capital (Credit + Retained)		33,192	32,650	32,415	45,184	45,713	46,278
Combined ROE - Total Capital (Credit + Retained)		29.0%	25.3%	22.6%	14.0%	14.0%	14.0%

Operating Profitability Metrics & Other Key Statistics

	2004E	**2005E**	**2006E**	**2007E**	**2008E**	**2009E**
As a % of Avg. Retained Portfolio						
Net Interest Income	1.22%	1.09%	0.95%	0.77%	0.77%	0.76%
Guarantee Fees	-0.21%	-0.20%	-0.21%	-0.21%	-0.21%	-0.21%
NII net of G-fees	1.01%	0.89%	0.74%	0.57%	0.56%	0.55%
SGA	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%
Pretax Income	0.96%	0.83%	0.69%	0.51%	0.51%	0.50%
Tax	0.27%	0.24%	0.19%	0.14%	0.14%	0.14%
Operating Return on Avg. Assets	0.65%	0.57%	0.47%	0.32%	0.32%	0.32%
Operating Return on Avg. Common Equity	33.72%	26.77%	21.92%	9.71%	9.61%	9.49%
Common Equity / Avg. Retained Portfolio	1.93%	2.13%	2.13%	3.34%	3.34%	3.34%

(1) Assumes retained portfolio pays G-fees to credit guarantee business
*(2) A portion of NII is allocated to G-fee business (4 bps * Book of Business). NIM is based on historical cost accounting and includes purchased option amortization expense*

Source: Company data, Morgan Stanley Research estimates

Fannie Mae

Residual Income Valuation Model *(5 years - Non-bank Version)*

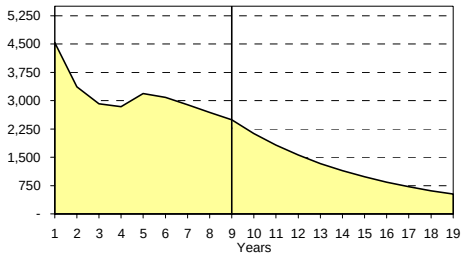
Credit Guarantee

Assumptions

Share Information	
Expected 12 Month Dividend (2005)	$0.00
Current Stock Price	$57.68
Issued Shares (million)	970
Reported Core Book Value Per Share	13.22
Cost of Capital	
10-yr. Govt. Bond Yield (%)	4.61
Beta	0.85
Market Risk Premium (%) (adj 09/02)	4.00
Cost of Common Equity (%)	8.01
1-yr. Govt. Bond Yield (%)	3.45
Cost of Common Equity (%) for price target	6.85
Maturity Phase	
Number of Years	6
Target Capital Ratio (%)	0.45
End of Phase RWA Growth Rate (%)	6.0
Decline Phase	
Decay Factor (0-10%)	7.5
Growth in RWA (%)	6.0
Goodwill	
Current Goodwill	0
BV Adjustment	0

Valuation Analysis

Present Value of Residual Income (%)



Key Valuation Measures

Stock Price	57.68
Est. Current Fair Value ($)	39.93
12 Month Target Price ($)	42.66
12 Month Total Return (%)	(26.0)
Price/Book Value	4.4
Price/Economic Book Value	5.4
2005E Return on Economic Equity (%)	32.3
Cost of Common Equity (%)	8.0
Current Operations Value™/Est. Fair Value (%)	108

Valuation Drivers

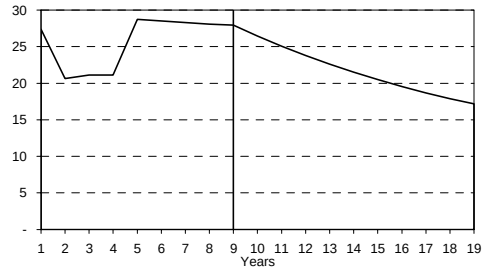
		CAGR (%)		End of Phase		% of Fair Value	
Phase	Years	Cash Earnings	RWA	ROEE (%)	Payout Ratio (%)	Phase	Cumulative
Economic BV	-	-	-	-	-	26.7	26.7
Development	5	2.4	4.7	35.2	86.2	26.2	52.9
Maturity	6	3.1	5.5	31.0	71.2	25.6	78.4
Decline	19	(0.3)	6.0	9.7	8.5	21.6	100.0

Valuation Parameters

	Est. Current Fair Value as a Multiple of Bk Val	Econ Bk	Earnings	Cash Earn
2005	3.5	3.5	12.5	12.5
2006	3.4	3.4	12.3	12.3
2007	3.2	3.2	12.2	12.2
2008	4.0	4.0	11.7	11.7
2009	3.8	3.8	11.4	11.4

Return on Economic Equity

ROEE (%)



Distribution of Forecasted ROEE

ROEE Frequency (%)	ROEE Threshold (%)
75	15
65	18
55	23
50	25
45	27
35	28
25	32

Source: Morgan Stanley Research estimates. Estimated current fair market value and 12-month price target do not include any subjective premiums or discounts

Please see analyst certification and other important disclosures starting on page 58.

Fannie Mae

Residual Income Valuation Model *(5 years - Non-bank Version)*

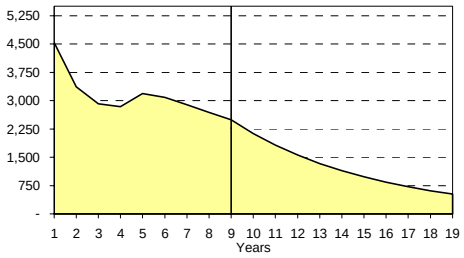
Retained Portfolio

Assumptions

Share Information	
Expected 12 Month Dividend (2005)	$0.00
Current Stock Price	$57.68
Issued Shares (million)	970
Reported Core Book Value Per Share	23.76
Cost of Capital	
10-yr. Govt. Bond Yield (%)	4.61
Beta	0.85
Market Risk Premium (%) (adj 09/02)	4.00
Cost of Common Equity (%)	8.01
1-yr. Govt. Bond Yield (%)	3.45
Cost of Common Equity (%) for price target	6.85
Maturity Phase	
Number of Years	2
Target Capital Ratio (%)	4.17
End of Phase RWA Growth Rate (%)	0.0
Decline Phase	
Decay Factor (0-10%)	10.0
Growth in RWA (%)	0.0
Goodwill	
Current Goodwill	0
BV Adjustment	0

Valuation Analysis

Present Value of Residual Income (%)



Key Valuation Measures

Stock Price	57.68
Est. Current Fair Value ($)	29.07
12 Month Target Price ($)	31.06
12 Month Total Return (%)	(46.1)
Price/Book Value	2.4
Price/Economic Book Value	3.0
2005E Return on Economic Equity (%)	27.7
Cost of Common Equity (%)	8.0
Current Operations Value™/Est. Fair Value (%)	228

Valuation Drivers

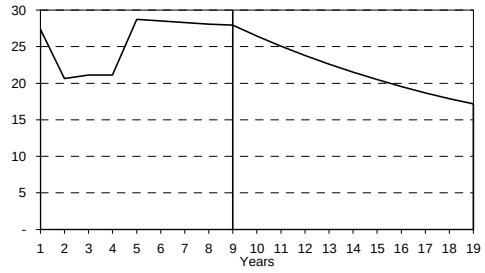
		CAGR (%)		End of Phase		% of Fair Value	
Phase	Years	Cash Earnings	RWA	ROEE (%)	Payout Ratio (%)	Phase	Cumulative
Economic BV	-	-	-	-	-	65.8	65.8
Development	5	(14.3)	0.0	9.5	100.0	26.0	91.9
Maturity	6	0.0	0.0	9.5	100.0	4.8	96.7
Decline	19	(0.8)	0.0	8.2	100.0	3.3	100.0

Valuation Parameters

	Est. Current Fair Value as a Multiple of			
	Bk Val	Econ Bk	Earnings	Cash Earn
2005	1.6	1.6	5.9	5.9
2006	1.6	1.6	7.4	7.4
2007	1.0	1.0	10.7	10.7
2008	1.0	1.0	10.8	10.8
2009	1.0	1.0	10.9	10.9

Return on Economic Equity

ROEE (%)



Distribution of Forecasted ROEE

ROEE Frequency (%)	ROEE Threshold (%)
75	8
65	8
55	9
50	9
45	9
35	9
25	9

Source: Morgan Stanley Research estimates. Estimated current fair market value and 12-month price target do not include any subjective premiums or discounts

Please see analyst certification and other important disclosures starting on page 58.

Appendix B: FRE Segment Data and Valuation

	2003E	2004E	2005E	2006E	2007E	2008E	2009E
Assumptions							
NIM (%)	0.75%	0.75%	0.72%	0.67%	0.60%	0.60%	0.60%
G-fees (bps)	23.3	17.5	18.4	19.0	20.0	20.0	20.0
Credit Guarantee - SGA/Total Book (bps)	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Retained Portfolio - SGA/Retained Portfolio	4.0	4.0	4.0	4.0	4.0	4.0	4.0
NCO / Avg. Total Book (bps)	1.1	0.8	0.9	1.5	2.0	2.3	2.5
REO / Total Book of Business (bps)	0.0	0.0	0.3	0.4	0.5	0.5	0.5
Tax rate - Credit Guarantee (%)	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%
Tax rate - Retained Portfolio (%)	28.2%	28.2%	28.2%	28.2%	28.2%	28.2%	28.2%
Total MBS/PC Outstanding - growth (%)	7.4%	4.0%	7.2%	7.0%	7.0%	7.0%	7.0%
Retained Portfolio - growth (%)	9.5%	1.2%	6.0%	0.0%	0.0%	0.0%	0.0%
Common Equity / Total Equity	85.4%	85.3%	86.9%	88.3%	80.0%	80.0%	80.0%
Preferred Dividend Rate (%)	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%
Avg. Retained Portfolio ($ mm)	605,037	647,435	672,252	692,112	692,112	692,112	692,112
Avg. Net PCs Outstanding ($ mm)	733,450	812,718	879,537	967,028	1,061,187	1,161,937	1,269,740
Avg. Total PCs Outstanding ($ mm)	1,090,158	1,187,085	1,253,526	1,345,128	1,439,287	1,540,037	1,647,840
Avg. Total Book of Business ($ mm)	1,335,793	1,460,152	1,551,789	1,659,140	1,753,299	1,854,049	1,961,852
Credit Guarantee							
Guarantee Fees	2,071	2,210	2,851	3,152	3,507	3,708	3,924
Net Interest Income	218	214	226	242	259	277	297
Other Income	-	219	233	249	263	278	294
SGA	815	891	947	1,012	1,070	1,131	1,197
Loss Provision + REO	2	140	177	340	473	552	638
Housing Tax Credit Partnerships	200	281	170	170	170	170	170
Pre-Tax Income	1,272	1,331	2,016	2,121	2,316	2,411	2,510
Taxes	729	333	504	530	579	603	628
Operating Income	543	998	1,512	1,591	1,737	1,808	1,883
Less Preferred Dividends	(63)	(79)	(94)	(46)	(82)	(87)	(92)
Operating Income Available to Common	481	919	1,418	1,545	1,655	1,721	1,791
Avg. Net PCs Outstanding ($ mm)	733,450	812,718	879,537	967,028	1,061,187	1,161,937	1,269,740
Avg. Total PCs Outstanding ($ mm)	1,090,158	1,187,085	1,253,526	1,345,128	1,439,287	1,540,037	1,647,840
Avg. Total Book of Business ($ mm)	1,335,793	1,460,152	1,551,789	1,659,140	1,753,299	1,854,049	1,961,852
Capital Requirement	0.45%	0.45%	0.45%	0.45%	0.45%	0.45%	0.45%
Required Capital	6,011	6,571	6,983	7,466	7,890	8,343	8,828
plus surplus	-	3,614	2,095	-	-	-	-
Total Capital	6,011	10,185	9,078	7,466	7,890	8,343	8,828
Capital Ratio	0.45%	0.70%	0.59%	0.45%	0.45%	0.45%	0.45%
Preferred Equity	1,202	1,528	1,816	876	1,578	1,669	1,766
Common Equity	4,809	8,657	7,262	6,590	6,312	6,675	7,063
ROE - Total Capital	9.0%	9.8%	16.7%	21.3%	22.0%	21.7%	21.3%
ROE - Common Equity		10.6%	19.5%	23.4%	26.2%	25.8%	25.4%

Operating Profitability Metrics & Other Key Statistics						
	2004E	**2005E**	**2006E**	**2007E**	**2008E**	**2009E**
As a % of Avg. Book of Business						
Net Interest Income	0.01%	0.01%	0.01%	0.01%	0.01%	0.02%
Guarantee Fees	0.15%	0.18%	0.19%	0.20%	0.20%	0.20%
Other Income	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%
SGA	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%
Loss Provision + REO	0.01%	0.01%	0.02%	0.03%	0.03%	0.03%
Housing Tax Credit Partnerships	0.02%	0.01%	0.01%	0.01%	0.01%	0.01%
Pretax Income	0.09%	0.13%	0.13%	0.13%	0.13%	0.13%
Tax	0.02%	0.03%	0.03%	0.03%	0.03%	0.03%
After-tax Income	0.07%	0.10%	0.10%	0.10%	0.10%	0.10%
Operating Return on Avg. Assets	0.06%	0.09%	0.09%	0.09%	0.09%	0.09%
Operating Return on Avg. Common Equity	10.6%	19.5%	23.4%	26.2%	25.8%	25.4%
Common Equity / Avg. Book of Business	0.59%	0.47%	0.40%	0.36%	0.36%	0.36%

Source: Company data, Morgan Stanley Research estimates

Please see analyst certification and other important disclosures starting on page 58.

Retained Portfolio - New Regime - FRE

	2003E	2004E	2005E	2006E	2007E	2008E	2009E
Assumptions							
NIM (%)	0.75%	0.75%	0.72%	0.67%	0.60%	0.60%	0.60%
G-fees (bps)	23.3	17.5	18.4	19.0	20.0	20.0	20.0
Retained Portfolio - SGA/Retained Portfolio (bps)		4.0	4.0	4.0	4.0	4.0	4.0
NCO/Avg. Net Portfolio (bps)	1.1	0.8	0.9	1.5	2.0	2.3	2.5
REO / Total Book of Business (bps)	0.0	0.0	0.3	0.4	0.5	0.5	0.5
Tax rate - Retained Portfolio (%)	28.2%	28.2%	28.2%	28.2%	28.2%	28.2%	28.2%
Retained Portfolio - growth (%)	9.5%	1.2%	6.0%	0.0%	0.0%	0.0%	0.0%
Net Interest Income	5,323	5,481	5,336	5,086	4,512	4,494	4,475
Purch Options Amort.		-	-	-	-	-	-
Other Income		-	-	-	-	-	-
SGA		259	269	277	277	277	277
Pre-Tax Income		5,222	5,067	4,809	4,236	4,217	4,198
Taxes		1,473	1,429	1,356	1,194	1,189	1,184
Operating Income		3,750	3,638	3,453	3,041	3,028	3,014
Less Preferred Dividends		(160)	(186)	(93)	(302)	(302)	(302)
Operating Income Available to Common		3,589	3,452	3,360	2,739	2,726	2,712
Avg. Retained Portfolio ($ mm)		647,435	672,252	692,112	692,112	692,112	692,112
Avg. Total Book of Business ($ mm)		1,460,152	1,551,789	1,659,140	1,753,299	1,854,049	1,961,852
Capital Requirement		2.05%	2.05%	2.05%	4.05%	4.05%	4.05%
Required Capital		13,272	13,781	14,188	28,031	28,031	28,031
plus surplus		7,300	4,134	1,000	1,000	1,000	1,000
Total Capital		20,572	17,916	15,188	29,031	29,031	29,031
Capital Ratio		3.18%	2.67%	2.19%	4.19%	4.19%	4.19%
Preferred Equity		3,086	3,583	1,783	5,806	5,806	5,806
Common Equity		17,486	14,332	13,406	23,224	23,224	23,224
ROE - Total Capital		18.2%	20.3%	22.7%	10.5%	10.4%	10.4%
ROE - Common Equity		20.5%	24.1%	25.1%	11.8%	11.7%	11.7%
Combined Capital (Credit + Portfolio)		30,757	26,993	22,654	36,920	37,374	37,859
Combined ROE - Total Capital (Credit + Portfolio)		15.4%	19.1%	22.3%	12.9%	12.9%	12.9%

Operating Profitability Metrics & Other Key Statistics

	2004E	2005E	2006E	2007E	2008E	2009E
As a % of Avg. Retained Portfolio						
Net Interest Income	0.85%	0.79%	0.73%	0.65%	0.65%	0.65%
SGA	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%
Pretax Income	0.81%	0.75%	0.69%	0.61%	0.61%	0.61%
Tax	0.23%	0.21%	0.20%	0.17%	0.17%	0.17%
Operating Return on Avg. Assets	0.55%	0.51%	0.49%	0.40%	0.39%	0.39%
Operating Return on Avg. Common Equity	20.5%	24.1%	25.1%	11.8%	11.7%	11.7%
Common Equity / Avg. Retained Portfolio	2.70%	2.13%	1.94%	3.36%	3.36%	3.36%

Source: Company data, Morgan Stanley Research estimates

Please see analyst certification and other important disclosures starting on page 58.

Freddie Mac

Residual Income Valuation Model *(5 years - Non-bank Version)*

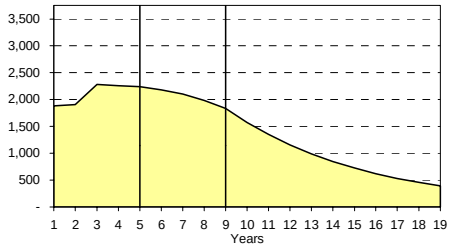
Credit Guarantee

Assumptions

Share Information	
Expected 12 Month Dividend (EOP 2005)	$0.00
Current Stock Price	$65.01
Issued Shares (million)	691
Reported Core Book Value Per Share (4Q04)	$14.75
Cost of Capital	
10-yr. Govt. Bond Yield (%)	4.61
Beta	0.85
Market Risk Premium (%)	4.00
Cost of Common Equity (%)	8.01
1-yr. Govt. Bond Yield (%)	3.45
Cost of Common Equity (%) for price target	6.85
Maturity Phase	
Number of Years	6
Target Total Equity/Book of Business (%)	0.45
End of Phase RWA Growth Rate (%)	6.0
Decline Phase	
Decay Factor (0-10%)	7.5
Growth in RWA (%)	6.0
Goodwill	
Current Goodwill	
BV Adjustment	

Valuation Analysis

Present Value of Residual Income (%)



Key Valuation Measures

Stock Price	65.01
Est. Current Fair Value ($)	30.96
12 Month Target Price ($)	33.08
12 Month Total Return (%)	(49.1)
Price/Book Value	4.4
Price/Economic Book Value	4.8
2005E Return on Economic Equity (%)	16.4
Cost of Common Equity (%)	8.0
Current Operations Value™/Est. Fair Value (%)	89

Valuation Drivers

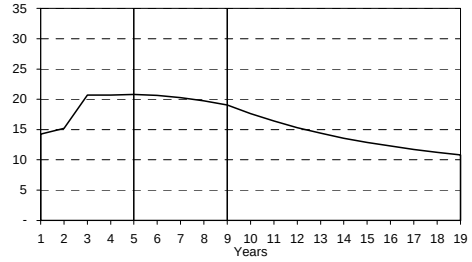
		CAGR (%)		End of Phase		% of Fair Value	
Phase	Years	Cash Earnings	RWA	ROEE (%)	Payout Ratio (%)	Phase	Cumulative
Economic BV	-	-	-	-	-	43.7	43.7
Development	5	6.0	5.7	25.9	77.4	20.6	64.3
Maturity	4	3.6	5.9	23.7	62.5	15.2	79.5
Decline	19	0.8	6.0	9.2	3.2	20.5	100.0

Valuation Parameters

	Est. Current Fair Value as a Multiple of			
	Bk Val	Econ Bk	Earnings	Cash Earn
2005	2.8	2.8	15.1	15.1
2006	3.1	3.1	13.8	13.8
2007	3.3	3.3	12.9	12.9
2008	3.1	3.1	12.4	12.4
2009	2.9	2.9	11.9	11.9

Return on Economic Equity

ROEE (%)



Distribution of Forecasted ROEE

ROEE Frequency (%)	ROEE Threshold (%)
75	12
65	13
55	15
50	16
45	17
35	20
25	23

Source: Morgan Stanley Research estimates. Estimated current fair market value and 12-month price target do not include any subjective premiums or discounts

Please see analyst certification and other important disclosures starting on page 58.

Freddie Mac

Residual Income Valuation Model *(5 years - Non-bank Version)*

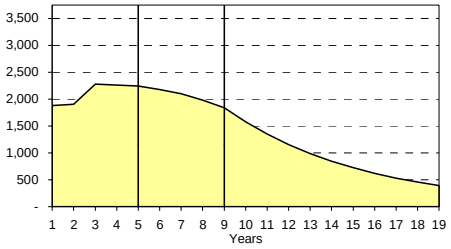
Retained Portfolio

Assumptions

Share Information	
Expected 12 Month Dividend (EOP 2005)	$0.00
Current Stock Price	$65.01
Issued Shares (million) (4Q04)	691
Reported Core Book Value Per Share (4Q04)	$29.79
Cost of Capital	
10-yr. Govt. Bond Yield (%)	4.61
Beta	0.85
Market Risk Premium (%)	4.00
Cost of Common Equity (%)	8.01
1-yr. Govt. Bond Yield (%)	3.45
Cost of Common Equity (%) for price target	6.85
Maturity Phase	
Number of Years	2
Target Total Equity/Book of Business (%)	4.19
End of Phase RWA Growth Rate (%)	0.0
Decline Phase	
Decay Factor (0-10%)	10.0
Growth in RWA (%)	0.0
Goodwill	
Current Goodwill	
BV Adjustment	

Valuation Analysis

Present Value of Residual Income (%)



Key Valuation Measures

Stock Price	65.01
Est. Current Fair Value ($)	43.50
12 Month Target Price ($)	46.48
12 Month Total Return (%)	(28.5)
Price/Book Value	2.2
Price/Economic Book Value	2.4
2005E Return on Economic Equity (%)	19.7
Cost of Common Equity (%)	8.0
Current Operations Value™/Est. Fair Value (%)	155

Valuation Drivers

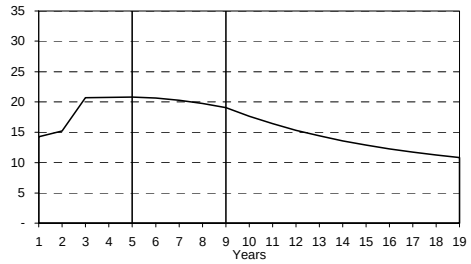
		CAGR (%)		End of Phase		% of Fair Value	
Phase	Years	Cash Earnings	RWA	ROEE (%)	Payout Ratio (%)	Phase	Cumulative
Economic BV	-	-	-	-	-	62.8	62.8
Development	5	(5.8)	0.0	11.7	100.0	22.6	85.5
Maturity	4	0.0	0.0	11.7	100.0	6.9	92.4
Decline	11	(2.2)	0.0	9.2	100.0	7.6	100.0

Valuation Parameters

	Est. Current Fair Value as a Multiple of			
	Bk Val	Econ Bk	Earnings	Cash Earn
2005	2.0	2.0	8.7	8.7
2006	2.2	2.2	8.9	8.9
2007	1.3	1.3	11.0	11.0
2008	1.3	1.3	11.0	11.0
2009	1.3	1.3	11.1	11.1

Return on Economic Equity

ROEE (%)



Distribution of Forecasted ROEE

ROEE Frequency (%)	ROEE Threshold (%)
75	9
65	9
55	10
50	10
45	10
35	11
25	11

Source: Morgan Stanley Research estimates. Estimated current fair market value and 12-month price target do not include any subjective premiums or discounts

Please see analyst certification and other important disclosures starting on page 58.

Morgan Stanley ModelWare℠

ModelWare is a proprietary framework for financial analysis created by Morgan Stanley Research. This new framework rests on the principles of comparability, transparency, and flexibility, and aims to provide investors with better tools to view the anticipated performance of an enterprise. The result of an 18-month global effort, ModelWare harmonizes the underlying data and calculations in Morgan Stanley models with a broad set of consistently defined financial metrics. Our analysts have populated the database with over 2.5 million data points, based on an extensive taxonomy of more than 3,500 unique metrics and more than 400 Morgan Stanley calculations. The ModelWare framework will also have the flexibility to allow analysts and investors to quickly customize their own analytical approach.

What makes the ModelWare architecture distinctive lies in the separation of data from calculations. Its transparency will permit users to see every component of every calculation, to choose elements or recombine them as they wish without laborious adjustments or recalculations. When choices must be made in defining standard or industry-specific measures, ModelWare defaults to economic logic, rather than favoring one accounting rule over another. This discipline facilitates comparability across sectors and regions. Underlying the ModelWare data is a new set of systems that check the internal consistency of forecast data in each of our analyst's models.

ModelWare EPS illustrates the approach taken. It represents ModelWare net income divided by average fully diluted shares outstanding. ModelWare net income sums net operating profit after tax (NOPAT), net financial income or expense (NFE), and other income or expense. ModelWare adjusts reported net income to improve comparability across companies, sectors, and regions. These adjustments include the following: We exclude goodwill amortization and items deemed by analysts to be "one-time" events; we capitalize operating leases where their use is significant (e.g., in transportation and retail); and we convert inventory to FIFO accounting when LIFO costing is used. For more information on these adjustments and others, as well as additional background, please see "Morgan Stanley ModelWare (ver. 1.0): A Road Map for Investors," by Trevor Harris and team, August 2, 2004.

Please see analyst certification and other important disclosures starting on page 58.

Analyst Certification

The following analysts hereby certify that their views about the companies and their securities discussed in this report are accurately expressed and that they have not received and will not receive direct or indirect compensation in exchange for expressing specific recommendations or views in this report: Kenneth Posner.

Important US Regulatory Disclosures on Subject Companies

The information and opinions in this report were prepared by Morgan Stanley & Co. Incorporated and its affiliates (collectively, "Morgan Stanley").

As of May 31, 2005, Morgan Stanley beneficially owned 1% or more of a class of common equity securities of the following companies covered in this report: Fannie Mae and Freddie Mac.

Within the last 12 months, Morgan Stanley managed or co-managed a public offering of securities of Fannie Mae.

Within the last 12 months, Morgan Stanley has received compensation for investment banking services from Fannie Mae and Freddie Mac.

In the next 3 months, Morgan Stanley expects to receive or intends to seek compensation for investment banking services from Fannie Mae and Freddie Mac.

Within the last 12 months, Morgan Stanley has received compensation for products and services other than investment banking services from Fannie Mae and Freddie Mac.

Within the last 12 months, Morgan Stanley has provided or is providing investment banking services to, or has an investment banking client relationship with, the following companies covered in this report: Fannie Mae and Freddie Mac.

Within the last 12 months, Morgan Stanley has either provided or is providing non-investment banking, securities-related services to and/or in the past has entered into an agreement to provide services or has a client relationship with the following companies covered in this report: Fannie Mae and Freddie Mac.

The research analysts, strategists, or research associates principally responsible for the preparation of this research report have received compensation based upon various factors, including quality of research, investor client feedback, stock picking, competitive factors, firm revenues and overall investment banking revenues.

Stock Ratings

Different securities firms use a variety of rating terms as well as different rating systems to describe their recommendations. For example, Morgan Stanley uses a relative rating system including terms such as Overweight, Equal-weight or Underweight (see definitions below). A rating system using terms such as buy, hold and sell is not equivalent to our rating system. Investors should carefully read the definitions of all ratings used in each research report. In addition, since the research report contains more complete information concerning the analyst's views, investors should carefully read the entire research report and not infer its contents from the rating alone. In any case, ratings (or research) should not be used or relied upon as investment advice. An investor's decision to buy or sell a stock should depend on individual circumstances (such as the investor's existing holdings) and other considerations.

Global Stock Ratings Distribution

(as of June 30, 2005)

	Coverage Universe		Investment Banking Clients (IBC)		
Stock Rating Category	Count	% of Total	Count	% of Total IBC	% of Rating Category
Overweight/Buy	680	35%	263	40%	39%
Equal-weight/Hold	880	46%	300	46%	34%
Underweight/Sell	362	19%	91	14%	25%
Total	1,922		654		

Data include common stock and ADRs currently assigned ratings. For disclosure purposes (in accordance with NASD and NYSE requirements), we note that Overweight, our most positive stock rating, most closely corresponds to a buy recommendation; Equal-weight and Underweight most closely correspond to neutral and sell recommendations, respectively. However, Overweight, Equal-weight, and Underweight are not the equivalent of buy, neutral, and sell but represent recommended relative weightings (see definitions below). An investor's decision to buy or sell a stock should depend on individual circumstances (such as the investor's existing holdings) and other considerations. Investment Banking Clients are companies from whom Morgan Stanley or an affiliate received investment banking compensation in the last 12 months.

Analyst Stock Ratings

Overweight (O). The stock's total return is expected to exceed the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

Equal-weight (E). The stock's total return is expected to be in line with the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

Underweight (U). The stock's total return is expected to be below the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

More volatile (V). We estimate that this stock has more than a 25% chance of a price move (up or down) of more than 25% in a month, based on a quantitative assessment of historical data, or in the analyst's view, it is likely to become materially more volatile over the next 1-12 months compared with the past three years. Stocks with less than one year of trading history are automatically rated as more volatile (unless otherwise noted). We note that securities that we do not currently consider "more volatile" can still perform in that manner.

Unless otherwise specified, the time frame for price targets included in this report is 12 to 18 months. Ratings prior to March 18, 2002: SB=Strong Buy; OP=Outperform; N=Neutral; UP=Underperform. For definitions, please go to www.morganstanley.com/companycharts.

Analyst Industry Views

Attractive (A). The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be attractive vs. the relevant broad market benchmark named on the cover of this report.

In-Line (I). The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be in line with the relevant broad market benchmark named on the cover of this report.

Cautious (C). The analyst views the performance of his or her industry coverage universe over the next 12-18 months with caution vs. the relevant broad market benchmark named on the cover of this report.

Stock price charts and rating histories for companies discussed in this report are also available at www.morganstanley.com/companycharts. You may also request this information by writing to Morgan Stanley at 1585 Broadway, 14th Floor (Attention: Research Disclosures), New York, NY, 10036 USA.

Other Important Disclosures

This research report has been published in accordance with our conflict management policy, which is available at www.morganstanley.com/institutional/research/conflictpolicies.

For a discussion, if applicable, of the valuation methods used to determine the price targets included in this summary and the risks related to achieving these targets, please refer to the latest relevant published research on these stocks. Research is available through your sales representative or on Client Link at www.morganstanley.com and other electronic systems.

This report does not provide individually tailored investment advice. It has been prepared without regard to the individual financial circumstances and objectives of persons who receive it. The securities discussed in this report may not be suitable for all investors. Morgan Stanley recommends that investors independently evaluate particular investments and strategies, and encourages investors to seek the advice of a financial adviser. The appropriateness of a particular investment or strategy will depend on an investor's individual circumstances and objectives.

This report is not an offer to buy or sell any security or to participate in any trading strategy. In addition to any holdings disclosed in the section entitled "Important US Regulatory Disclosures on Subject Companies", Morgan Stanley and/or its employees not involved in the preparation of this report may have investments in securities or derivatives of securities of companies mentioned in this report, and may trade them in ways different from those discussed in this report. Derivatives may be issued by Morgan Stanley or associated persons.

Morgan Stanley & Co. Incorporated and its affiliate companies do business that relates to companies covered in its research reports, including market making and specialized trading, risk arbitrage and other proprietary trading, fund management, investment services and investment banking. Morgan Stanley sells to and buys from customers the equity securities of companies covered in its research reports on a principal basis.

Morgan Stanley makes every effort to use reliable, comprehensive information, but we make no representation that it is accurate or complete. We have no obligation to tell you when opinions or information in this report change apart from when we intend to discontinue research coverage of a subject company.

With the exception of information regarding Morgan Stanley, reports prepared by Morgan Stanley research personnel are based on public information. Facts and views presented in this report have not been reviewed by, and may not reflect information known to, professionals in other Morgan Stanley business areas, including investment banking personnel.

Morgan Stanley research personnel conduct site visits from time to time but are prohibited from accepting payment or reimbursement by the company of travel expenses for such visits.

The value of and income from your investments may vary because of changes in interest rates or foreign exchange rates, securities prices or market indexes, operational or financial conditions of companies or other factors. There may be time limitations on the exercise of options or other rights in your securities transactions. Past performance is not necessarily a guide to future performance. Estimates of future performance are based on assumptions that may not be realized.

This publication is disseminated in Japan by Morgan Stanley Japan Limited; in Hong Kong by Morgan Stanley Dean Witter Asia Limited; in Singapore by Morgan Stanley Dean Witter Asia (Singapore) Pte. (Registration number 199206298Z) and/or Morgan Stanley Asia (Singapore) Securities Pte Ltd (Registration number 200008434H), regulated by the Monetary Authority of Singapore, which accepts responsibility for its contents; in Australia by Morgan Stanley Dean Witter Australia Limited A.B.N. 67 003 734 576, holder of Australian financial services licence No. 233742, which accepts responsibility for its contents; in Taiwan by Morgan Stanley & Co. International Limited, Taipei Branch; in Korea by Morgan Stanley & Co. International Limited, Seoul Branch; in India by JM Morgan Stanley Securities Private Limited; in Canada by Morgan Stanley Canada Limited, which has approved of, and has agreed to take responsibility for, the contents of this publication in Canada; in Spain by Morgan Stanley, S.V., S.A., a Morgan Stanley group company, which is supervised by the Spanish Securities Markets Commission (CNMV) and states that this document has been written and distributed in accordance with the rules of conduct applicable to financial research as established under Spanish regulations; in the United States by Morgan Stanley & Co. Incorporated and Morgan Stanley DW Inc., which accept responsibility for its contents. Morgan Stanley & Co. International Limited, authorized and regulated by Financial Services Authority, disseminates in the UK research that it has prepared, and approves solely for the purposes of section 21 of the Financial Services and Markets Act 2000, research which has been prepared by any of its affiliates. Private U.K. investors should obtain the advice of their Morgan Stanley & Co. International Limited representative about the investments concerned. In Australia, this report, and any access to it, is intended only for "wholesale clients" within the meaning of the Australian Corporations Act.

Additional information on recommended securities is available on request.

Morgan Stanley

The Americas
1585 Broadway
New York, NY 10036-8293
United States
Tel: +1 (1)212 761 4000

Europe
25 Cabot Square, Canary Wharf
London E14 4QA
United Kingdom
Tel: +44 (0)20 7425 8000

Japan
20-3, Ebisu 4-chome
Shibuya-ku,
Tokyo 150-6008, Japan
Tel: +81 (0)3 5424 5000

Asia/Pacific
Three Exchange Square
Central
Hong Kong
Tel: +852 2848 5200