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The Interest Rate Risk of Fannie Mae and Freddie Mac

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Abstract

This paper evaluates the interest rate risk of Fannie Mae and Freddie Mac (F&F) and develops related public policy proposals. F&F merit special attention due to (1) their potentially very large interest rate risk, and (2) their status as U.S. government sponsored enterprises. The analysis focuses on the dynamic hedging strategy and extensive use of interest rate derivatives employed by F&F to control their interest rate risk. While dynamic hedging is highly cost effective for F&F, it creates imperfect hedges and thus could impose significant costs on U.S. taxpayers in a potential future F&F bailout. The policy discussion includes proposals to modify the F&F interest rate disclosures and the OFHEO stress test, and to create rate interest risk standards for F&F.

Key words: Fannie Mae, Freddie Mac, government sponsored enterprises, interest rate risk, mortgage market.

1. Introduction

This paper evaluates the exposure of Fannie Mae and Freddie Mac (F&F) to interest rate risk, and develops public policy proposals for disclosing and controlling this risk. F&F merit special attention because (1) their exposure to interest rate risk is potentially very large, and (2) their status as U.S. government sponsored enterprises (GSEs) raises special concerns.

1.1. The policy perspective

The U.S. Congress has provided F&F an implicit guarantee of their debt obligations, as well as other benefits, in order to induce lower mortgage interest rates in the United States.[1] At the same time, the rates of return on equity for F&F have been very high, usually ranging between 20% and 30% annually, about double that of most other large

1 The F&F charters and related legislative materials are available on the web page of their regulator, the Office of Federal Housing Enterprise Oversight, http://www.ofheo.gov/docs/#Regulations. For further discussion of the benefits provided to F&F, and their effectiveness in reducing mortgage interest rates, see Ambrose and Warga (2002), Congressional Budget Office (2001a,b), Frame and Wall (2002a), and other papers cited therein. Current developments in 2002 and early 2003 to expand F&F financial disclosures are not considered in this paper, because F&F interest rate risk is not a focus of these developments; see, however, Department of the Treasury, Office of Federal Housing Enterprise Oversight and Securities and Exchange Commission (2003).

financial institutions. As part of an earlier Congressionally mandated study of F&F, Hermalin and Jaffee (1996) concluded that F&F's high rates of return are closely related to their duopoly power in the market for securitizing conforming mortgages, power which derives from their government provided benefits.[2] The high profit rates of F&F may also reflect their own efficiency, but it is unlikely that F&F would be able to maintain the full extent of these profit rates in a competitive environment.[3]

F&F's duopoly power plays a key role in how they manage their interest rate risk. Specifically, it is shown below that the profitability of the current F&F hedging strategy depends on this market power. It is also shown below that the F&F hedging strategy places potential interest rate risks with the federal government, without conferring corresponding benefits on mortgage borrowers. This is the basis for the paper's proposals, first to expand F&F interest rate risk disclosures, and second to limit the amount of interest rate risk that F&F might potentially impose on U.S. taxpayers.

1.2. The business lines of F&F

F&F operate in two distinct lines of business, mortgage-backed securitization and retained mortgage portfolios. For the mortgage securitization line, F&F purchase and transform sets of whole mortgage loans into mortgage-backed securities (MBS), which are then sold to capital market investors (hereafter referred to as F&F investor-held MBS). F&F guarantee these MBS against the risk of default, for which they obtain an annual guarantee fee. F&F retain no direct interest rate risk on the investor-held MBS, since all cash flows are owned by the investors.[4] In contrast, for their retained mortgage portfolios, F&F directly purchase various mortgage-related securities, including, increasingly, the repurchase of their own MBS from the capital markets.[5] Figure 1 shows that since about 1991, the F&F retained mortgage portfolios have been generally growing relative to their investor-held MBS, the ratio reaching about 0.80 as of 2001. Figure 1 also shows that while Freddie Mac previously had quite a small retained mortgage portfolio, the strategies of the two firms are now converging.

The profit structures for the two F&F business lines differ substantially. Profits on the F&F investor-held MBS line derive primarily from the annual fee they receive for guaranteeing the timely payment of interest and principal. The average guarantee fee for

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2 To be clear, I have no information that suggests F&F are violating U.S. antitrust laws.

3 Competition would force F&F to distribute all their government-provided benefits as lower mortgage interest rates, or lose market share. Recent proposals and initiatives for GNMA and the Federal Home Loan Banks to enter the conforming mortgage market represent steps toward increasing such competition.

4 F&F may earn interest income on the float created by the time lag between the date when interest payments are received from borrowers and the date when payments are made to MBS security holders. The interest rate risk associated with this float is now small and is not considered further in this paper.

5 F&F have recently been annually repurchasing about 50% of their newly issued MBS each year. By year-end 2001, F&F had retained approximately 33% of their total issued MBS, up from only 2% in 1991. MBS repurchases by F&F raise interesting questions of market microstructure and the potential use of asymmetric information, but an analysis of such issues is beyond the scope of the present paper.

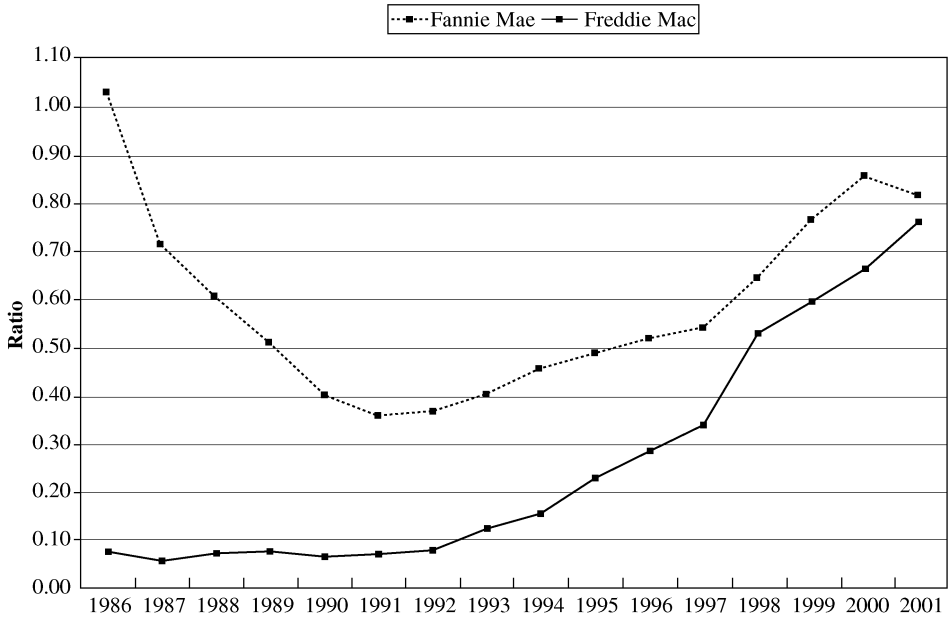

Figure 1. **Size of F&F retained portfolios relative to their investor-held MBS outstanding.** Since the early 1990s, the retained mortgage portfolios of F&F have grown rapidly through the repurchase of their own MBS. *Source*: OFHEO (2002a).

the most recent year 2001 was 19 basis points (bp).[6] Profits on the retained mortgage portfolios, in contrast, are based on the spread between the interest return on the mortgage assets and the interest cost of the funding liabilities. The average F&F rate spread for 2001 was 104 bp, computed as the retained portfolio net interest income divided by the average of the beginning and ending balances for the retained portfolio. Conceptually, this spread can be further separated into two components:

$$\text{Retained portfolio rate spread} = \text{default risk premium} + \text{residual premium}. \quad (1)$$

The default risk premium represents the compensation for future default losses on the mortgage portfolio, and is reasonably measured by the same guarantee fee that F&F charge on their investor-held MBS. The residual premium is then that part of the rate spread not accounted for by default risk. It represents the compensation that F&F receive for bearing other risks—mainly interest rate and liquidity risks—associated with their retained mortgage portfolios.

Figure 2 compares the guarantee fee income that F&F earn on their investor-held MBS

6 This is computed as the annual guarantee fee income divided by the corresponding average MBS balance. All aggregate F&F data reported in this paper are from the 2001 annual report of the OFHEO (2002a).

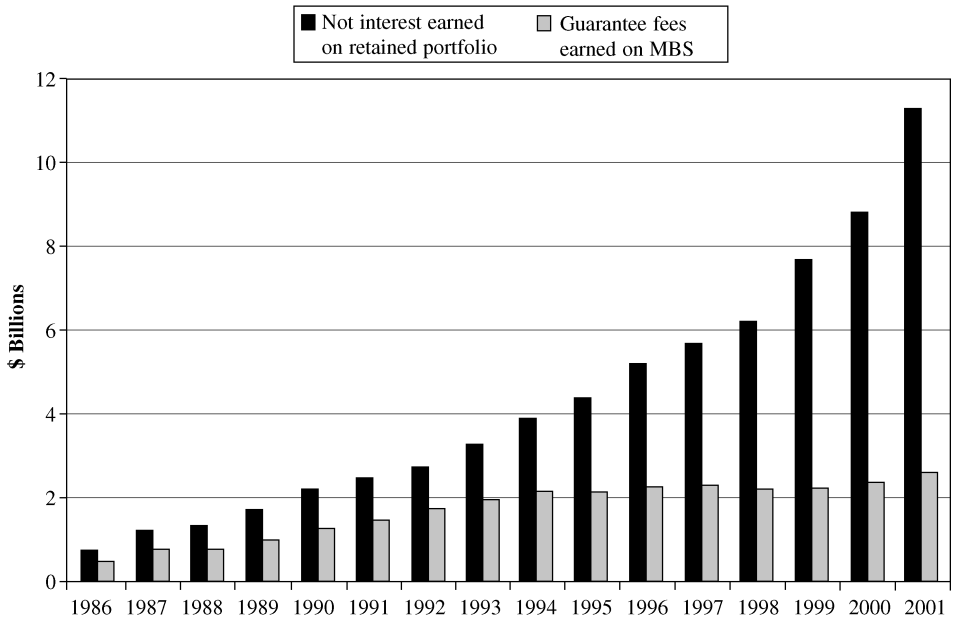

Figure 2. **Primary sources of F&F profits.** F&F operate two primary business lines, retained mortgage portfolios and MBS issues. MBS revenues reflect the guarantee fees charged and have been quite stable in recent years. The net interest earned on the retained portfolios, in contrast, has expanded rapidly in line with the growing size of the portfolios. FAS 133 effects have been removed from the 2001 data for comparability with past data. *Source*: OFHEO (2002a).

with the net interest income they earn on their retained mortgage portfolios.[7] F&F's aggregate income is now dominated by the retained portfolio component. Furthermore, more than three-fourths of the portfolio rate spread is attributable to the residual (interest rate and liquidity risk) component. This is illustrated in figure 3, where, for example, for the year 2001, of the 104 bp total rate spread, 19 bp is attributed to the default risk premium, leaving 85 bp attributed to the residual risk premium.[8] It is also apparent in figure 3 that the rate spreads earned on the F&F retained portfolios have been declining steadily since 1991. F&F have been able to achieve their rapidly rising retained portfolio

7 These data exclude relatively small amounts of fee income that F&F earn from a variety of other sources, such as underwriting REMIC securities. The income values in figure 2 are gross of operating expenses and taxes; data net of expenses and taxes are shown in table 1. FAS 133 introduced new accounting rules for derivative securities beginning with 2001. The earlier system actually provided more economically meaningful accounting values for our purposes. Thus the data used in this paper all exclude the effects of the FAS 133 rules from the 2001 data; this also retains direct comparability with earlier years.

8 The default risk component is assumed to equal the guarantee fee rate actually earned on F&F investor-held MBS. The residual premium is then computed by subtracting the guarantee fee rate from the total interest rate spread. Yield spreads are computed relative to the average of the beginning and end of year balances for the retained mortgage portfolio. Data are from OFHEO (2002a).

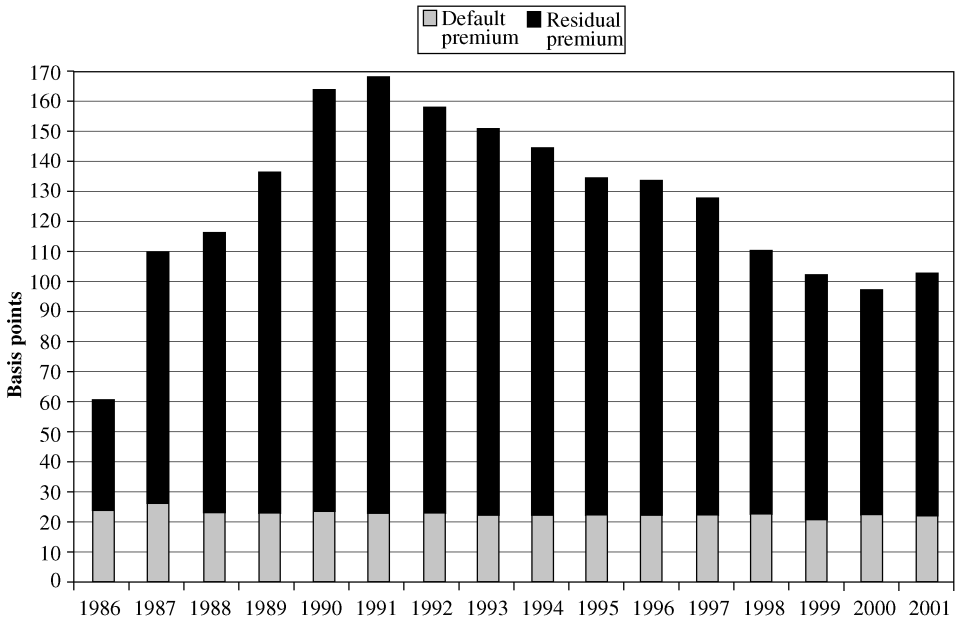

Figure 3. **Rate spreads on retained portfolios by components in basis points (bp).** The rate spread (the mortgage portfolio return minus the cost of funding the portfolio) that F&F earn or their retained portfolios can be separated into a default premium and a residual. The default premium is assumed to equal the guarantee fee (stated in bp) the firms earned from their mortgage-backed security guarantees. The residual is the net interest rate spread minus the guarantee fee, reflecting compensation for the interest rate and liquidity risks associated with the retained mortgage portfolios. *Source*: OFHEO (2002a). *See also* note 8.

profits (figure 2), in the presence of declining rate spreads, only by rapidly expanding the size of their retained portfolios (figure 1).

New investment decisions for the two business lines will depend on their returns on equity (ROE). Table 1 provides historical data, with ROE computed as income net of administrative expenses and taxes divided by regulatory capital.[9] It is apparent, for both F&F, that the retained portfolio ROEs substantially exceed the MBS ROEs, except for Fannie Mae in 1998. It is thus not surprising that F&F have been significantly expanding their retained portfolios relative to their MBS business in recent years. The generally higher Fannie Mae ROE is related to the firm's more limited hedging of rate risk as shown below.

The remainder of this paper analyzes and evaluates how F&F manage the interest rate risks associated with their retained mortgage portfolio. The high profit rates earned on the retained mortgage portfolios, together with the implicit government guarantee of F&F debt, leave little doubt that larger retained portfolios are in the best interests of F&F shareholders. The key issue is whether this activity and its associated hedging strategy are

9 The minimum capital requirements are 0.45% for the off-balance sheet MBS line and 2.5% for the on-balance sheet retained portfolio line. These values basically represent binding constraints for F&F.

Table 1. **Return on equity (ROE) by business line**
Each firm has two business lines, the retained mortgage portfolio and MBS. The ROE for each line is computed as (adjusted operating income)/(average required regulatory capital). For both firms, the ROE on the retained portfolios has generally been significantly higher than the ROE on the MBS line. *Source*: Fannie Mae and Freddie Mac *Information Statements*.

	Retained Portfolio			Mortgaged-Backed Securities		
	Adjusted Operating Income ($ Million)	Average Regulatory Capital ($ Million)	ROE (%)	Adjusted Operating Income ($ Million)	Average Regulatory Capital ($ Million)	ROE (%)
A. Fannie Mae						
2001	4904	16,412	29.9	804	3522	22.8
2000	3749	14,132	26.5	667	3118	21.4
1999	3243	11,730	27.6	678	2962	22.9
1998	2624	9150	28.7	820	2737	30.0
1997	2519	7539	33.4	549	2536	21.6
B. Freddie Mac						
2001	2925	11,924	24.5	460	2751	16.7
2000	2153	10,575	20.4	386	2506	15.4
1999	1883	8029	23.5	335	2287	14.7
1998	1329	5253	25.3	371	2147	17.3
1997	1095	3780	29.0	300	2135	14.0

Notes:
Adjusted operating income (after tax):
(a) Excludes extraordinary items in all years.
(b) Excludes FAS 133 adjustments in 2001.

Line allocations based on Fannie Mae & Freddie Mac Information Statements:
(a) Guarantee fee earned only on investor-held MBS business line.
(b) Credit expenses are allocated by mortgage balances across the 2 lines.

Average regulatory capital (average of beginning and ending balance):
(a) Equals 2.5% of retained portfolio.
(b) Equals 0.45% of investor held MBS outstanding.
ROE = adjusted operating income/average regulatory capital.

imposing interest rate risks on U.S. taxpayers, and, if so, what policy actions should be taken to rectify the situation.

2. Hedging the interest rate risk on a mortgage portfolio

A mortgage portfolio is defined as the mortgage assets held and the bonds (or other debt instruments) and equity used to finance these assets. Derivative securities that may be used to hedge mortgage portfolio interest rate risks are treated separately below. Also putting aside other (relatively minor) asset and liability items, we have:

$$\text{Mortgage assets} = \text{bond liabilities} + \text{equity}. \tag{2}$$

Book values for the three items are shown on the balance sheets of financial firms such as F&F. Many financial firms, including F&F, also use market prices to compute market values for their assets and liabilities, from which the market value of equity can be directly derived:

$$\text{Market value of equity} = \text{market value of mortgage assets} - \text{market value of bond liabilities.} \quad (3)$$

2.1. Sources and measurement of interest rate risk

Interest rate changes are among the most important factors leading to changes in the market value of mortgage assets and bond liabilities, and thus in the market value of the portfolio's equity. Interest rate risk arises because unexpected changes in interest rates may cause mortgage asset values to fall relative to liability values, thus leading to an unexpected decline in the market value of equity. In an extreme case, the market value of equity can become negative, leading to the possible bankruptcy and liquidation of the financial firm.

This is exactly what happened to a significant part of the S&L industry in the early 1980s. The S&L industry was prone to interest rate risk because many firms were financing their long-term, fixed-rate, mortgages with short-term deposit liabilities. When interest rates rapidly escalated starting in 1976, the market value of their mortgage portfolios fell as much as 25%, wiping out the equity of many firms (which had averaged only about 5% of assets previous to the shock). At the same time and for the same reason, the market value of Fannie Mae's net worth also became negative. The situation did not create a crisis for Fannie Mae only because investors had confidence that the U.S. government would bail out Fannie Mae's debts if necessary. Fortunately, interest rates soon fell and Fannie Mae's solvency was restored. The pattern of 1- and 10-year Treasury interest rates over the last 50 years is shown in figure 4, and the interest rate peak in 1981 is a clear landmark.

A mismatch between asset and liability maturities or duration is not the only source of interest rate risk on a mortgage portfolio. Most U.S. fixed-rate mortgages allow the borrower to prepay the debt at any point, an option that allows borrowers to refinance their homes when interest rates decline. Unexpected prepayments are then a second major source of potential losses in the market value of equity for a mortgage portfolio. A key offset occurs, however, if the portfolio manager has used callable bonds to finance the mortgage portfolio. In this case, the manager can exercise the call options on the bonds to offset the effects of mortgage borrowers exercising their prepayment options, leaving the market value of equity unaffected.

In summary, interest rate risk can arise on a mortgage portfolio for two fundamental reasons:

(1) There is a maturity mismatch between the mortgage assets and the bond liabilities;
(2) The prepayment options on the mortgage assets are not matched by bond call options.

Figure 4. **Treasury constant maturity interest rates.** Between 1976 and 1981, U.S. interest rates rose by over 1000 basis points. Between 1981 and 1986, U.S. interest rates fell by over 1000 basis points. Such extreme interest rate volatility over a relatively short span of time creates substantial interest rate risk for F&F. *Source*: Series H15 release of the Board of Governors of the Federal Reserve System.

In either case, the amount of interest rate risk would be properly measured by the potential loss in the market value of equity that would arise from future changes in interest rates.[10]

2.2. A Perfect balance sheet hedge of interest rate risk

To start the discussion of hedging strategies, note that financial firms such as F&F can perfectly eliminate all interest rate risk from a mortgage portfolio by meeting two conditions:

(1) The date and amount of each scheduled mortgage asset cash inflow must be matched with a corresponding liability cash outflow.
(2) Each optional mortgage cash inflow (based on the prepayment option) must be matched with an optional liability cash outflow (based on the bond call option).

10 Alternatively, interest rate risk can be measured by the change in future income flows that result from unexpected changes in interest rates. In fact, Fannie Mae regularly measures some of its interest rate risk this way. The advantage of the change in the market value of equity is that the relevant information is contained in a single value. In contrast, income flow data at every future date are required to convey the same information.

Table 2. **How F&F finance their assets**
For both firms, debt due within one-year is in excess of 40% of total assets. Thus from a balance sheet perspective, the firms are funding long-term assets with shorter-term debt. Also, for both firms, callable debt is less than 25% of total fixed rate mortgages. The call options on callable debt hedge the prepayment options on the mortgage assets, but this hedge exists for less than 25% of the mortgages. *Source*: Fannie Mae and Freddie Mac *Information Statements*.

	Freddie Mac			Fannie Mae		
As of 12/31/2001	$ Billions	% of assets	% of Fixed-rate mortgages	$ Billions	% of assets	% of Fixed-rate mortgages
Debt, within 1 year	250	**40.55**		343	**42.95**	
Debt, after 1 year	312	50.48		420	52.51	
Other liabilities	40	6.48		18	2.28	
Stockholders' equity	15	2.49		18	2.27	
Total	617	100.00		800	100.00	
Callable debt	96		**22.17**	140		**21.08**
Fixed-rate mortgages	433		100.00	664		100.00

F&F can meet these conditions by issuing a suitable array of long-term and callable bonds, to be called a *perfect balance sheet hedge*.[11] Interest rate risk that arises because the balance sheet hedge is imperfect will be called *balance sheet rate risk*.

F&F do not carry out perfect balance sheet hedges, since to do so would significantly reduce their profits. This is demonstrated by two key features of their balance sheet (see table 2):

(1) F&F debt due in one year exceeds 40% of their total assets, far more than the percentage of their scheduled mortgage payments due within one year.[12] To create a perfect balance sheet hedge, F&F would have to substitute long-term for short-term debt, but this would be costly: as of June 2002, for example, the long- and short-term rate spread on F&F debt was about 250 bp.
(2) Just over 20% of F&F fixed-rate mortgages are covered by callable debt, whereas essentially all fixed-rate mortgages have prepayment options. To create a perfect balance sheet, F&F would have to substitute more costly callable debt for non-callable debt.

11 A perfect balance sheet hedge is also sometimes called a perfect cash flow or zero maturity gap hedge. A perfect balance sheet hedge is also protected against ''counterparty risk'', as discussed below in the context of derivative hedging.

12 F&F do not disclose the percentage of mortgages due in one year, but it should be far less than 40%.

Table 3. **F&F use of interest rate derivatives**
The two firms rank among the world's largest users of interest rate derivatives. They use interest-rate swaps to transform short-term, balance-sheet, debt into synthetic long-term debt. They use option-based derivatives to hedge the prepayment options on their mortgage assets. *Source*: Fannie Mae and Freddie Mac *Information Statements*.

	Freddie Mac Derivatives, ($ billions as of 12/31/2001)		Fannie Mae Derivatives, ($ billions as of 12/31/2001)	
	Notional amount	Net fair value	Notional amount	Net fair value
Interest-rate swaps	443	− 6.0	300	− 8.9
Option-based	408	5.2	220	6.3
Other	201	0.0	13	− 1.5
Total	1052	− 0.8	533	− 4.1

2.3. Hedging interest rate risk with interest rate derivatives

Interest rate derivatives provide an alternative to balance sheet hedging for F&F interest rate risks. In fact, F&F are among the world's largest users of these derivatives; see table 3. The two primary derivative categories used to hedge interest rate risk are interest rate swaps and option-based derivatives (in particular, swaptions). These derivatives often provide the most cost-effective means for F&F to hedge their interest rate risk.

2.3.1. The profitability of rate swaps. F&F use interest rate swaps to convert short-term, balance-sheet, debt into synthetic long-term debt, thereby improving the maturity match with their long-term mortgage assets. The swap contracts commit F&F to make fixed long-term rate payments (the equivalent of long-term debt) and to receive short-term interest rate payments (offsetting the future volatility of the interest payments on their short-term debt). If properly organized, interest rate swaps can eliminate all the interest rate risk arising from balance sheet maturity imbalances.

If the yield curve in the swap market is flatter than the yield curve in the spot agency market, moreover, then the synthetic long-term rate created with swaps will be lower than the corresponding spot market rate for long-term agency bonds. In other words, with this yield curve condition, swaps will be the cost-effective means for F&F to hedge their balance sheet rate risk. Table 4 shows that the yield curves in these two markets on June 6, 2002 met this condition; in fact, this is generally the case.[13] As a numerical example, assume that one of the firms needed to issue a 10-year bond to hedge its mortgage portfolio at the June date. Table 4 shows that the cost of issuing a 10-year agency bond in the spot market was 5.59%. Alternatively, the swap strategy has the firm issue 1-year agency debt in the spot market at a cost of 2.45%, then enter into a swap (receive 1-year, pay 10-year) at a net cost of 2.92% ($= 5.51\% - 2.59\%$), resulting in a total cost of 5.37%

13 Many interest-rate swap markets use LIBOR as the base short rate, and these markets are primarily used by F&F. Libor-based swap markets create a basis risk, since F&F short-term debt is related to Agency rates, not Libor rates. Thus, changes in the Libor-Agency rate spread creates basis risk.

Table 4. **Yield curves for agency spot and agency swap markets**
Yield curves exist for both the spot markets in agency debt and for interest-rate swaps based on agency security interest rates. The data for June 6, 2002 are typical, in that the yield curve in the agency spot market is steeper than the yield curve in the agency swap market. *Source*: Fannie Mae web page.

Interest Rates for Agency Spot and Agency Swap Markets (as of June 6, 2002)			
Maturity	Agency spot (%)	Agency swap (%)	Difference (bp)
1 year	2.45	2.59	− 14
2 year	3.32	3.47	− 15
5 year	4.68	4.72	− 4
10 year	5.59	5.51	+ 8
30 year	6.38	6.12	+ 26

(= 2.45% + 2.92%). The result is a saving of 22 bp (= 5.59% − 5.37%) relative to using the agency spot bond markets to create the balance sheet hedge.

It is not necessarily a bad thing that F&F use their GSE status to hedge their interest rate risk at a low cost. Specifically, mortgage interest rates will be lower to the extent that F&F increase the size of their retained portfolios in response to the incentive provided by low-cost hedging. Increasing their retained portfolios, however, will also erode the, F&F net interest spread, and thus will conflict at some point with their profit maximization. Indeed, we have already noted that F&F earn a substantial residual rate spread (80 bp or higher in recent years, as shown in figure 3) on their retained portfolio, which suggests they are retaining—and not passing through to mortgage borrowers—a large part of the benefits of their low-cost hedging opportunities.

2.3.2. Risks associated with F&F swaps. Concerns have been raised that F&F's use of interest rate swaps creates transactional risks, some of which may be borne by U.S. taxpayers. In particular, counterparty default risk—the possibility that a counterparty would default on a contract and subject F&F to a loss—has received considerable attention.[14] The danger due to this form of counterparty risk, however, appears to be exaggerated. The key point is that F&F require each counterparty to post collateral on a weekly basis to offset all capital losses in the value of the counterparty's position. Thus, the maximum direct financial loss that could be sustained by F&F is limited to the amount created by a one-week change in interest rates. A major loss for F&F from this source is thus unlikely.

However, there is another, potentially larger, form of counterparty risk, that I will call counterparty rollover risk. The issue here is that F&F must replace the swap positions of a defaulting counterparty, whether or not the default creates a direct loss for F&F. Replacing such swap positions may be very costly, partly because the counterparty failure is likely to occur at a time of disrupted financial markets, and partly because other counterparties will

14 As note earlier in footnote 11, perfect balance sheet hedges have no counterparty exposure.

be aware of F&F's need to renew its hedge positions and will try to take advantage of this in their pricing.

Another form of rollover risk, short-term debt rollover risk, arises because F&F must reissue large amounts of short-term debt annually in conjunction with their interest rate swaps. Table 2 shows that F&F must roll over more than 40% of their total bond positions each year. The risk occurs if financial markets become severely disrupted, even for a reason unrelated to F&F, and investors refuse to purchase any new F&F debt. In this case, F&F would be unable to pay the principal on their maturing short-term debt, creating a major financial crisis or bailout.

To be sure, F&F recognize this risk and both firms indicate they maintain sufficient liquidity to survive for some time (3 months or longer) without access to rollover markets.[15] However, Frame and Wall (2002b) have noted that if F&F were unable to sell new debt, then they may also be unable to carry out sales of the ''liquid'' securities from their investment portfolio. The U.S. General Accounting Office (1998) has also pointed out that holding securities in their investment portfolios for liquidity purposes represents a highly profitable arbitrage for F&F, since the return on the assets exceeds the cost of the agency bonds used to fund the positions. Still another interesting perspective on liquidity risk is provided by Scholes (2000), in which a principal in long-term capital management (LTCM), discusses how the 1998 liquidity crisis led to the downfall of LTCM.

2.3.3. Hedging prepayment risk with swaptions. F&F use an interest rate derivative called a swaption—an option on a swap contract—to replace callable bonds for hedging mortgage prepayment options. Given that F&F use swap contracts in lieu of long-term bonds, it makes sense that F&F also use options on swap contracts in lieu of callable long-term bonds. The amount of swaptions and related option derivatives in use by F&F are shown in table 3 under the category ''option based''.

In principle, the economics of using swaptions in lieu of callable bonds could be analyzed in the same manner as our discussion of interest rate swaps. However, F&F do not disclose the detailed information that is needed to evaluate the profits they earn and the risks they bear with respect to swaptions. Nevertheless, it is reasonable to assume that swaptions provide F&F a low-cost means for hedging their interest rate prepayment risk in much the same way that swaps are effective in hedging duration risk.

2.4. The imperfect dynamic interest rate hedging strategy of F&F

F&F's strategy for hedging interest rate risk has one other component, in common with many large financial service firms, referred to here as imperfect dynamic hedging. It involves 3 steps:

(1) Maintain very complete hedges against the likely, near-term, interest rate shocks;

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15 These are part of Freddie Mac's and Fannie Mae's ''voluntary disclosures,'' which are prominently described on their web pages; see: http://www.freddiemac.com and http://www.fanniemae.com.

(2) Use less complete or even no hedges for longer-term and less likely rate shocks;
(3) Implement additional hedges as interest rate levels change, and the unlikely becomes likely.

This technique is described as dynamic hedging because the hedges are implemented in real time as market conditions change. It is described as imperfect dynamic hedging because at every date a range of longer-term and less likely rate risks are intentionally left unhedged.[16] The key observable result of imperfect dynamic hedging, to be developed in this section, is that the financial firm suffers losses when interest rate volatility reaches a threshold, and the losses may expand rapidly as interest rate volatility exceeds this threshold. In section 3, it is shown that the F&F interest rate risk demonstrates exactly these features.

2.4.1. The risks of imperfect dynamic hedging. F&F employ imperfect dynamic hedging to save costs. In the absence of such hedging, F&F would have to purchase interest rate derivatives to cover all possible interest rate outcomes, many of which would have a very low probability of occurring. Each derivative purchase, of course, entails a transaction cost. More importantly, the interest rate derivative markets become much less efficient—bid-ask spreads become much larger—for contracts involving large shocks and far away dates. Imperfect dynamic hedging avoids these high transaction costs, because the hedges required to offset unlikely rate shocks are implemented only as these events become more likely and the relevant derivative markets become more active and efficient.

While imperfect dynamic hedging reduces hedging costs for the most likely interest rate outcomes, the unlikely may still occur. In particular, a large loss can still occur, either because interest rates move by a very large amount over a very short span of time, or because interest rates change steadily and by large amounts over longer periods of time. This latent interest rate risk can be controlled by more complete hedging or by more frequent updating of the hedge positions, but these adjustments would eliminate the very transaction cost savings that motivated the strategy in the first place.[17] Thus, imperfect dynamic hedging represents a trade-off, in which the firm accepts the interest rate risks associated with certain low-probability outcomes, while receiving in return a substantial saving in transaction costs.

2.4.2. Going short interest rate volatility. Imperfect dynamic hedging implies that F&F are generally in a short position relative to interest rate volatility, meaning that the firms suffer losses whenever there are unexpected and significant interest rates changes

16 Imperfect dynamic hedging is an imperfect version of traditional ''delta'' hedging, in which the firm does not maintain the complete hedge ratio. The academic literature of imperfect dynamic hedging is very limited; see, however, Leland (1985, 2000).

17 In the extreme case, the positions can be updated continuously, in which case there is no retained interest rate risk, but the transactions costs become infinite.

in either direction. This is a common feature of imperfect dynamic hedging strategies because:

(1) The portfolios often have net positive duration—asset duration exceeds liability duration—even taking into account the contribution of swap derivatives. In the normal case of an ascending yield curve, positive duration expands the interest rate spread, but exposes the portfolio to losses whenever interest rates rise unexpectedly.
(2) Prepayment options on the mortgage portfolio are only partially hedged by callable bonds and swaptions. Imperfect hedging of the prepayment options reduces the cost of hedging, but exposes the portfolio to losses when interest rates fall unexpectedly.

Thus, F&F will perform best when interest rates are stable, and their performance will deteriorate the more that interest rates change, in either direction.[18]

A short position in rate volatility is profitable for F&F, since it means that they are selling liquidity to the marketplace; that is, the mortgages that F&F purchase and hold are decidedly less liquid than the bonds that they issue. F&F realize net income from this process because the less liquid mortgages have higher interest rates than the liquid agency bonds that support them (even after subtracting the default premium embodied in the mortgage rates). F&F are able to keep part of this net income because they hedge only part of the associated interest rate risk. The remaining risk is shifted in part to the federal government via the GSE status of F&F.

2.5. The cost of completely hedging the F&F retained mortgage portfolios

Having seen that F&F imperfectly hedge their interest rate risk, it is useful to consider what would be the cost to implement a complete hedge. A quantitative estimate of the cost of a complete hedge for the F&F retained mortgage portfolios can be derived by recognizing that a retained mortgage portfolio, when fully hedged against interest rate risk, is economically equivalent to F&F's investor-held MBS (assuming the underlying mortgages are identical). In both cases, F&F retain the default risk, but none of the interest rate risk. Consequently the rate of return should be the same for the two positions. (Of course, as shown in table 1, the ROEs that F&F actually earn on their retained mortgage portfolios are substantially higher than the ROEs for their MBS business line, precisely because the retained portfolio is not perfectly hedged.)

Table 5 provides a simple computation of the loss in income F&F would have incurred

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18 As shown in figure 3, the rate spread on the retained portfolio since 1991 has been declining, but has always been well above zero. Thus over this period, interest rate volatility has not threatened F&F solvency. However, as shown in figure 4, recent rate volatility has been an order of magnitude below what had been experienced just ten years earlier, during the early 1980s. Finally, it should be noted that F&F do carry out derivative trades to control their volatility exposure, but again cost considerations preclude carrying out perfect hedges.

Table 5. **The implicit cost of perfectly hedging the interest rate risk on the F&F retained portfolios**
F&F face no interest rate risk on their MBS business line, which is reflected in the relatively low ROE earned from that activity. Applying the ROE on the MBS business to the equity invested in the retained portfolio business line thus provides an estimate of the income that would be earned on a perfectly hedged retained portfolio. In this table, the ''actual'' row shows the actual income, capital (based on the 2.5% regulatory ratio), and ROE earned on the retained portfolio. The ''hedged'' rows used the actual capital, but the ROE earned on the MBS business line, to compute an income value which is an estimate of the income that would have been earned on a perfectly hedged retained portfolio. The results indicate perfect hedging would have cost each firm approximately $1 billion of annual earnings on its retained portfolio. *Source*: derived from data in table 1.

	In $ Millions for the Year 2001		
	ROE (%)	Capital	Income
Fannie Mae			
Actual	29.9	16,412	4904
Hedged	22.8	16,412	3746
Percentage loss of income			23.6%
Freddie Mac			
Actual	24.5	11,924	2925
Hedged	16.7	11,924	1994
Percentage loss of income			31.8%

had they completely hedged their retained mortgage portfolios. The ''actual'' rows use the historic data from table 1 for the ROE, required capital, and net interest income for each firm's retained portfolio business line. The ''hedged'' rows compute each firm's hypothetical hedged net interest income by applying the lower ROE associated with its MBS business line during 2001 (as shown in table 1) to the amount of capital it had actually investment in the retained portfolio. The idea is that the lower ROE on the MBS line is purged of any compensation for bearing interest rate risk, since no interest rate risk arises from issuing MBS. The ''actual'' income minus the ''hedged'' income is then an estimate of how much income the firm would have given up if it had perfectly hedged its retained portfolio. Table 5 shows that complete hedging would have cost each firm about $1 billion in annual income, equal to from 24% to 32% of the income each actually earned on its retained portfolio.[19]

2.6. Conclusions regarding F&F interest rate risk hedging tools

F&F face intrinsically huge amounts of interest rate risk as a result of their size and the mortgage securities they hold. Fortunately, two sets of instruments allow F&F to transfer as much of this risk as they desire to capital market investors:

19 This computation assumes that F&F hold the actual dollar amount of their capital fixed, even as the ROE earned on the retained portfolio is assumed to fall. In reality, the firms might well lower their capital base in this circumstance, which would cause the net income to fall even further.

(1) F&F can eliminate rate risks by issuing a suitable array of long-term and callable bonds.
(2) F&F can eliminate rate risks by entering into a suitable array of swap and swaption contracts.

The balance sheet information in table 2 indicates that F&F make only limited use of long-term and callable debt to hedge their interest rate risk. This is not surprising, since the information in tables 3 and 4 indicates that interest rate derivatives provide much lower-cost hedging tools. In addition, F&F employ a imperfect dynamic hedging strategy, in which they primarily hedge the risks associated with the more probable interest rate changes. A simple computation in table 5 indicates that each firm would have foregone about $1 billion in annual income if it had completely hedged its interest rate risk.

3. Measuring the retained interest rate risk of F&F

We now consider the disclosures provided by F&F that measure the extent of their retained interest rate risk, that is the amount of rate risk remaining after taking into account each firm's interest rate hedging activity. Today, most major financial firms measure their retained rate risk with a valuation model. Briefly put, these models compute the change in the market value of equity that occurs as the result of any hypothetical change in interest rates or interest rate scenarios. The models are used for several purposes, first to guide the firm's internal interest risk management, second to disclose publicly how much interest rate risk remains unhedged, and third to compute capital requirements. F&F are at the forefront of such firms, both in their use of these hedging methods and in the amount of their public disclosures.

3.1. Freddie Mac's retained interest rate risk

Table 6 shows the primary interest rate risk information released by Freddie Mac, called its portfolio market value sensitivity or PMVS. In Part A, the two PMVS-L measures are based on an instantaneous parallel shift in the entire yield curve, for 50 bp and 100 bp shocks. The test measures the immediate change in the market value of equity, but does not consider effects that would evolve over only a longer period. The tests are carried out for both an upward and a downward shift in interest rates, and the results are provided for whichever direction creates the largest loss in the market value of equity. Part A also shows the impact of a 25 bp change in the yield curve, either a steepening or a flattening, whichever creates the greatest loss.[20] These data show that Freddie Mac's largest retained interest rate risk in recent years occurred at year-end 1998, when a 100 bp interest rate

20 The yield curve is measured by the spread between the 1- and 10-year bond rates, and the shock involves changing the 1-year rate by 12.5 bp in one direction and the 10-year rate by 12.5 bp in the opposite direction.

Table 6. **Freddie Mac's interest rate risk**
Freddie Mac discloses the loss in the market value of its equity that would result from 50 and 100 bp shifts in interest rates (PMVS-L) and from a 25 bp shift in the slope of the yield curve (PMVS-YC). The test is carried out for both falling and rising interest rates, and the results are shown for the larger of the effects. Freddie Mac also discloses the loss in the market value of its equity that would result from a 100 bp interest rate shift with and without the benefit of derivatives. *Source*: Freddie Mac Information Statement, March 2002.

Part A	Loss in market value of equity %			Loss in market value of equity ($ Millions)		
As of 12/31	PMVS-L 50 bp (%)	PMVS-L 100 bp (%)	PMVS-YC 25 bp (%)	PMVS-L 50 bp	PMVS-L 100 bp	PMVS-YC 25 bp
2001	2.2	8.8	0.3	262	1031	36
2000	2.5	8.5	n/a	272	924	n/a
1999	0.8	2.9	n/a	102	366	n/a
1998	3.9	14.0	n/a	362	1300	n/a

Part B	Loss in market value of equity %		
PMVS-L 100 bp	Before Derivatives	Derivative Benefit	After Derivatives
3/31/2002	28.5	19.5	9.0
12/31/2001	28.9	18.6	10.3
3/31/2001	23.5	12.0	11.5

shock would have caused a 14% or $1.3 billion loss in the market value of its equity. The test for a yield curve steepness shock was introduced only recently, and the first readings suggest it is not as sensitive as the 100 bp parallel shock.

A further aspect of Freddie Mac's interest rate risk is revealed by comparing the PMVS-L effects for the 50 bp and 100 bp shocks. For example, at December 31, 2001, a 50 bp shock caused a 2.2% loss in the market value of equity, whereas a 100 bp shock caused a 8.8% loss. The loss in market value of equity thus rises much more than proportionately as the size of the rate shock rises—here, a doubling in the rate shock leads to a four-fold loss in market value of equity. This is a common feature of mortgage portfolio interest rate risk and is technically referred as a convexity effect.[21] The key implication is that the results that Freddie Mac provide for 50 and 100 bp shocks cannot be extrapolated to larger interest rate shocks, since the amount of convexity that corresponds to such larger rate shocks is not disclosed.

Part B of table 6 shows PMVS results that isolate the effect of interest rate derivatives in reducing Freddie Mac's interest rate risk. The ''before derivatives'' results correspond to what was earlier called balance sheet rate risk, and these results confirm the large amount of this risk that Freddie Mac retains. The ''derivative benefit'' column of Part B shows that the derivatives remove from one-third to one-half of the balance sheet risk. The ''after derivatives'' column shows the retained interest rate risk, comparable to Part A of table 6,

21 See Tuckman (2002) for a discussion of convexity and its application to mortgage securities.

except that the results in Part B are quarterly averages of tests made each day of the quarter. Although not displayed in table 6, Freddie Mac also releases graphs of the daily distribution of PMVS-L results for 50 bp shocks over the last four years. These data are available because Freddie Mac uses this PMVS tool for managing and adjusting its interest rate risk on a daily basis.

3.2. Fannie Mae's retained interest rate risk

Table 7A shows comparable retained interest rate risk information released by Fannie Mae. These data are similar in concept to Freddie Mac's PMVS measure, but differ in two respects:

(1) Fannie Mae shows separate results for a 100 bp increase and a 100 bp decrease in interest rates, whereas Freddie Mac discloses only the result for the most severe of the two changes.
(2) Fannie Mae includes the change in the market value of the firm's guarantee fee income as a result of the interest rate change. Since guarantee fee income declines when interest rates fall (due to mortgage prepayments), this accounts for the large losses (23–29%) Fannie Mae displays in the falling rate scenario.

It is a disappointing aspect of the Fannie Mae and Freddie Mac disclosures in Part A of tables 6 and 7 that they cannot be directly compared as a result of these two points.[22]

Fannie Mae also discloses its ''effective duration gap'' as illustrated in table 7B, showing the duration of Fannie Mae's assets minus its liabilities, including derivative effects. This is a market value sensitivity measure, but it is accurate only for small changes in interest rates, owing to the large convexity of the retained portfolios. Table 7B shows that Fannie Mae's effective duration shifted suddenly from positive to negative values in mid-2002, reaching a value of negative 14 months in August 2002. A negative duration value indicates that the portfolio is at risk with respect to downward shocks in interest rates. This dramatic change in Fannie Mae duration was the result of an unexpected surge in mortgage prepayments, which removed large amounts of long-term mortgages from its balance sheet. It provides another indication that Fannie Mae has imperfectly hedged the prepayment risk associated with its mortgage portfolio.

The announcement by Fannie Mae of this unexpected increase in its interest rate risk raised concern in the financial markets. Fannie Mae's regulator, the Office of Federal Housing Enterprise Oversight, announced it would verify that Fannie Mae took actions to

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22 F&F each use their own proprietary model for portfolio valuation, and this factor could also lead to lack of comparability, even if the disclosure formats were the same. Fannie Mae also discloses the impact of 100 bp shocks on the amount of net interest income that is lost (or gained) cumulatively, for 1- and 4-year horizons. This has limited value for measuring the aggregate amount of Fannie Mae's interest rate risk, because it does not account for the valuation changes created by cash flows beyond the four year horizon; see Frame and Wall (2000b) for a further critique of this Fannie Mae disclosure.

Table 7. **Fannie Mae's interest rate risk**
Fannie Mae discloses the loss in the market value of its equity that would result from 100 bp increases and decrease in interest rates. Unlike Freddie Mac (in table 6), these results include the effect of the change in the value of their mortgage-backed security guarantee fee income. Fannie Mae also discloses its effective duration gap. In particular, in late 2002, Fannie Mae's duration gap rapidly changed to − 14 months, reflecting the shortening of its mortgage asset duration due to mortgage prepayments. *Source*: Fannie Mae *Information Statement*, October 2002.

	Loss in market value of equity 100 bp shock (%)		Loss in market value of equity 100 bp shock ($ Millions)	
As of 12/31	Rates Rise	Rates Fall	Rates Rise	Rates Fall
Part A				
2001	9	23	2168	5288
2000	2	28	473	5855
	Effective duration gap (months)			
Part B				
Jan-02	2			
Feb-02	− 2			
Mar-02	5			
Apr-02	0			
May-02	− 1			
Jun-02	− 4			
Jul-02	− 9			
Aug-02	− 14			
Sep-02	− 10			
Oct-02	− 6			

Note: includes change in the value of future guarantee fees.

reverse this development. One action taken by Fannie Mae was to call a significant quantity of its callable bonds, thus shortening the liability duration and raising the net duration indicator. By year-end 2002, Fannie Mae's net duration appeared to be moving in the right direction. It is noteworthy, however, that Fannie Mae's ability to adjust to future shocks is constrained by the limited amount of callable bonds it has issued. Freddie Mac appears to have been better hedged against unexpected prepayments and thus did not suffer a comparable erosion in its position.

3.3. Market value sensitivity versus VaR disclosures

Frame and Wall (2002b) compare the F&F rate risk disclosures with the value-at-risk (VaR) disclosures used by many commercial banks.[23] The F&F market value sensitivity

23 See Szegö (2002) and other papers in the July 2002 issue of the *Journal of Banking and Finance* for a comparison of VaR with other risk measures.

(hereafter MvS) and the VaR disclosure both rely on a valuation model to estimate a firm's likely loss from a change in interest rates. The VaR method, however, evaluates a wide range of possible interest rate scenarios, and then exhibits the loss associated with a specified level of loss severity. For example, VaR losses are usually exhibited at the level of the 95th or 99th percentile of the largest losses. Thus, a firm should suffer losses exceeding its VaR amount only 5% or 1% of the time. In contrast, the MvS measures are based on 50 bp or 100 bp shocks to all interest rates, which closely approximate the 95th and 99th percentiles for monthly interest rate changes.

VaR and MvS will provide exactly the same loss level result, assuming the same valuation model is used, if, say, the 95th percentile of all monthly rate changes corresponds exactly to the 95th percentile of losses generated by the VaR model. This condition will hold if larger interest rates shocks systematically create larger losses. This will generally be true for the rate risk on F&F retained mortgage portfolios, unless the firms intentionally window dress the results (for example, by hedging 100 bp rate risks, while leaving 75 bp rate risks unhedged).

Frame and Wall prefer VaR or a similar measure covering the range of exposures, in order to reveal the true losses even in the presence of window dressing. F&F, of course, deny any window dressing in their MvS releases. In the end, protection against window dressing, or fraud more generally, will require active intervention by the F&F regulator, the Office of Federal Housing Enterprise Oversight (OFHEO). OFHEO, for example, could use a system of random testing, and this may be most conveniently carried out under the existing MvS system.

3.4. The OFHEO stress test

The Federal Housing Enterprises Financial Safety and Soundness Act of 1992 required the OFHEO to issue risk-based capital regulations for F&F to be enforced through a specified stress test.[24] The stress test was officially implemented for the first time in September 2002. The stress test subjects F&F to rate shocks (relative to the average rate level of the preceding 9 months), over a 10-year period:[25]

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24 Extensive documentation concerning the stress test is provided on the OFHEO web page, including the 576 page final report, available at http://www.ofheo.gov/docs/regs/RBCFinal.pdf.

25 Stiglitz, Orszag and Orszag (2002) have argued that the likelihood of actually observing the stress test conditions are extremely low, at most 1% with regard to the interest rate conditions alone. However, this conclusion is based on a highly literal interpretation of the test, namely that interest rates rise rapidly in a 12-month period and then sustain that level for nine additional years. In contrast, if the test had been that interest rates change by 1000 bp steadily over a 5-year period, they would have likely found that the probability of such an event to be reasonably high, since it occurred twice in the 50-year history from 1952 to 2002 (see figure 4, first from 1976 to 1981 and then 1981 to 1986). Given the convexity in F&F hedging positions, it is quite possible that a 1000 bp change over a 5-year period would create much greater losses than the literal shock implemented in the OFHEO tests. In other words, even if the precise interest environment envisioned by the stress test is highly unlikely, the losses it measures may be much more likely since they could occur in a variety of interest rate environments.

Table 8. **Office of Federal Housing Enterprise Oversight Stress Test (OFHEO), September 30, 2002**
The first official application of the OFHEO stress test for F&F occurred on September 30, 2002. The test computes the RBC requirement for each firm. A firm passes the test if its actual capital equals or exceeds the RBC. Both firms passed the test, for both the high and low interest rate scenarios. The firms are also subject to a ''minimum capital requirement'' which equals 0.45% of their investor-held MBS and 2.5% of their balance sheet assets. The actual capital of both firms also exceeded this capital requirement. *Source*: OFHEO (2002b).

$ Billions	Fannie Mae	Freddie Mac
Risk-based capital requirement		
High interest rate scenario	18.887	4.919
Low interest rate scenario	21.440	0.732
Minimum capital requirement*	25.755	20.538
Actual capital	27.278	23.101

(1) The 10-year Treasury rate rises by 75%, constrained by a maximum permissible change of 600 bp. In the September 2002 stress test, the upward change was 455 bp; see OFHEO (2002b).
(2) The 10-year Treasury rate falls by 50%, constrained by a maximum decline of 600 bp. In the September 2002 stress test, the downward change was 145 bp.
(3) Both the rate increase (1) and decline (2) are implement steadily over a 12-month period; interest rates are then maintained at that level for the remaining nine years of the test.
(4) The yield curve is flat in the high-rate scenario, upward sloping in the low-rate scenario.
(5) All other interest rates that have an impact on F&F financial results are determined based on their average spread to the comparable maturity Treasury rate during the previous two years.

The test is made more severe by an assumed wave of mortgage defaults. The test also currently assumes that the firms do not put on any new business after the start date.[26] The test determines the ''risk based capital'' that Fannie Mae or Freddie Mac would have needed at the beginning of the test to cover all the loses that the shock creates over the 10 years, plus an additional 30% to cover ''operational risks''. A firm is deemed to pass the test if its actual capital exceeds the computed amount of required risked based capital.

Table 8 shows the results for the first official test carried out as of September 30, 2002, as reported in OFHEO (2002b). Both firms passed the test, indicating they had sufficient capital to cover any losses created by the stress scenario. Both firms, however, lost money in both the high- and low-rate scenarios, confirming that they maintain a short position with respect to interest rate volatility. Fannie Mae lost the most money in the low-rate

26 It is unclear whether this makes the test more or less severe. In particular, the stand-still requirement has the benefit for F&F that they take on no new positions during the 12-month period in which interest rates are rapidly changing, and on which they would probably suffer losses. This condition can be changed at a later date at the discretion of OFHEO.

regime, suggesting its primary risk concerns mortgage prepayments, consistent with the negative duration positions shown in table 7B and discussed above. Freddie Mac, in contrast, lost the most money in the high-rate regime, suggesting it has a positive net portfolio duration. If not corrected, Freddie Mac's profits would be expected to decline following the next significant upward shock in interest rates.

Since the stress test involves large rate shocks over a long time period, it provides an evaluation of the risks associated with the imperfect dynamic hedging strategies of F&F. In this way, it provides a highly useful complement to the F&F interest rate sensitivity disclosures. However, the OFHEO stress test could be improved, in particular to ensure that it measures all the relevant interest rate risks, and we now turn to such proposals in the next section.

4. Proposals and conclusions

This concluding section provides public policy proposals for disclosing and controlling F&F's interest rate risk based on the analysis of the paper. Proposals for modifying the F&F interest rate disclosures and the OFHEO stress test are followed by comments on the possible use of interest rate risk standards for F&F.

4.1. Modifications in interest rate disclosures: proposals for F&F

Seven proposals are offered based on the preceding discussion of the interest rate risk disclosures of Fannie Mae and Freddie Mac. Proposals (1)–(4) create direct comparability in the disclosures of the two firms. Proposals (5)–(7) call for expanded disclosures, although still within the spirit of what F&F are already providing.

(1) Freddie Mac should disclose market value sensitivity results for rate changes in both directions, not just the direction of the greatest loss.
(2) Freddie Mac should provide duration measures, comparable to the Fannie Mae disclosures.
(3) Fannie Mae should disclose market value sensitivity results without the effect of the change in guarantee fee income.
(4) Fannie Mae should disclose its market value sensitivity results with and without the effect of its interest rate derivative positions.
(5) Both Fannie Mae and Freddie Mac should disclose traditional maturity gap measures, as a directs means of measuring the extent of their balance sheet maturity imbalance.
(6) Both Fannie Mae and Freddie Mac should disclose market value sensitivity results for a much wider range of interest rate shocks.
(7) All data pertaining to interest rate risk should be released at least monthly, to allow changes in their interest rate exposure to be steadily tracked over time. This information could be released with a time lag to protect F&F confidentiality.

4.2. Modifications in interest rate disclosures: proposals for OFHEO

Additional actions concerning interest rate disclosure changes are proposed here for F&F's supervisory agency, the OFHEO. They are:

(1) OFHEO should require standardized disclosures for F&F, consistent with the F&F proposals (1) to (4) above, to facilitate comparisons between the two firms.
(2) OFHEO should institute random testing of F&F, with respect to both the size of rate shocks and the dates at which the tests are made. Otherwise, F&F could manage their interest rate derivatives to window dress their disclosures, making their positions appear better hedged than they actually are. Interest rate derivatives lend themselves to window dressing, since low-cost positions can be created that cover only a specific rate shock (say from 99 to 101 bp, but nothing else), or for a specific date (say from December 30 to January 2, but nothing else). Random testing is commonly used by banking regulators for this reason.
(3) OFHEO should institute a systematic program for validating the valuation models used by F&F. Other banking regulators commonly validate the pricing models used by the institutions they supervise, and OFHEO should adopt a similar technique.
(4) OFHEO should adopt an explicit strategy for how it would respond were one or the other of the firms to be revealed to hold an unexpectedly large amount of interest rate risk. This would avoid the need to make ad hoc responses in a crisis situation, as illustrated by the S&L regulator during the early 1980s. OFHEO should also obtain the power from Congress to place a failing firm under receivership were that deemed to be useful.

4.3. Modifications in the OFHEO stress test

There are four proposals to improve confidence that the stress test is achieving its goal:

(1) The OFHEO stress test should be expanded to evaluate a variety of different interest rate scenarios. One candidate, for example, would be to replicate the interest rate changes that were actually observed in the United States during the 10-year period from 1976 to 1986 (rates first rose by about 1000 bp during a 5-year period, then fell by about the same amount during the next 5-year period; see figure 4).
(2) OFHEO should implement random testing in terms of the size of rate changes and the date at which the test is implemented to avoid concerns of window dressing behavior. This proposal parallels the suggestions made earlier regarding the F&F interest rate disclosures, and could be combined with proposal (1).
(3) OFHEO should carry out and report continuing tests to validate its valuation model.
(4) OFHEO should prepare operational plans for how it would respond were Fannie Mae or Freddie Mac to fail the stress test at some future date.

4.4. Interest rate risk standards for F&F

The Congressional charters for F&F and related legislation set explicit standards for the credit risk that F&F are allowed to take on in carrying out their mortgage market mandates. For example, F&F can purchase mortgage loans with loan to value ratios up to 80% without additional credit enhancement, while specific enhancements such as private mortgage insurance are required when F&F acquire higher ratio loans. It is intriguing, therefore, that Congress has not set similar standards for the interest rate risks that F&F accumulate. Specific interest rate risk standards for F&F are thus worth considering, based on the following factors:

- It is feasible for F&F to finance their retained mortgage portfolio in a fashion that creates no interest rate risk. The decision by F&F to hold interest rate risk is thus voluntary and reflects the expected profits that it creates.
- Although the expected profits from imperfect hedging may provide F&F incentive to expand the size of their retained portfolios, which would then create lower mortgage interest rates, this is not an argument for imperfect hedging. The F&F charters already require the firms to support the mortgage market, and it is feasible for the firms to do so through mortgage-backed securities, without taking on interest rate risk. The firms should thus support the mortgage market to the best of their capability, with or without the incentive of above-normal profit incentives.
- The F&F interest rate hedging strategies are focused on protecting their firms' capital against losses from frequently occurring interest rate changes. At the same time, the firms have not hedged against low probability interest rate scenarios for which the losses could far exceed their available capital resources, leaving taxpayers to pay the bill.
- Given that F&F are imperfectly hedging their interest rate risk, a very large and rapid change in interest rate levels could create the need for intervention by the federal government, creating significant costs for U.S. taxpayers.

Interest rate risk standards could be implemented by setting quantitative limits on the size of the retained mortgage portfolios that F&F may accumulate. Exemptions could be allowed to the extent that the firms demonstrate they had perfectly hedged the interest rate risk on some part of the retained portfolio. At the same time, F&F could readily accelerate their issuance of investor-held MBS in order to satisfy the Congressional mandate that they support the mortgage market.

4.5. Concluding comments

F&F should be commended for the interest rate disclosures they now provide. The specific proposals offered here are mainly extensions and refinements of what F&F already do. However, significant new information would be revealed if their market value sensitivity tests covered much larger interest rate shocks. A significantly more active role for OFHEO oversight of the F&F interest rate disclosures would also be beneficial. Perhaps the most

important proposal is for OFHEO to expand its stress test to cover a wider range of interest rate shocks and at random dates. The analysis also raised concern that the F&F dynamic hedging strategies have resulted in significant residual interest rate risk. While imperfect dynamic hedging is highly cost effective, it imposes significant potential costs on U.S. taxpayers in terms of a potential future F&F bailout.

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References

Ambrose, Brent, and Arthur Warga. ''Measuring Potential GSE Funding Advantages.'' *Journal of Real Estate Finance and Economics* 25, no. 2 (2002).

Congressional Budget Office. *Federal Subsidies and the Housing GSEs*. May, 2001a.

Congressional Budget Office. *Interest Rate Differentials Between Jumbo and Conforming Mortgages, 1995–2000*. May, 2001b.

Department of the Treasury, Office of Federal Housing Enterprise Oversight, and Securities and Exchange Commission. ''Enhancing Disclosure in the Mortgage-Backed Securities Markets.'' January, 2003.

Fannie Mae. *Information Statement*. April 1, 2002.

Frame, W. Scott, and Larry D. Wall. ''Finance Housing through Government-Sponsored Enterprises.'' *Federal Reserve Bank of Atlanta Economic Review* First quarter, 2002a.

Frame, W. Scott, and Larry D. Wall. ''Fannie Mae's and Freddie Mac's Voluntary Initiatives: Lessons from Banking.'' *Federal Reserve Bank of Atlanta Economic Review* First quarter, 2002b.

Freddie Mac. *Information Statement*. March 29, 2002.

Hermalin, Benjamin, and Dwight Jaffee. ''The Privatization of Fannie Mae and Freddie Mac: Implications for Mortgage Industry Structure.'' In *Studies on Privatizing Fannie Mae and Freddie Mac*. U.S. Department of Housing and Urban Development, May, 1996.

Leland, Hayne. ''Option Pricing and Replication with Transactions Costs.'' *Journal of Finance* XL, no. 5 (1985), 1283–1301.

Leland, Hayne. ''Optimal Portfolio Implementation with Transactions Costs and Capital Gains Taxes.'' Haas School of Business, University of California, Berkeley, 2000.

Office of Federal Housing Enterprise Oversight. *Final Risk-Based Capital Regulation* July 19, 2001, available at http://www.ofheo.gov/docs/rbc/rbcresults123002.pdf.

Office of Federal Housing Enterprise Oversight. *Annual Report to Congress* 2002a.

Office of Federal Housing Enterprise Oversight. ''OFHEO Announces First Official Classification of Fannie Mae and Freddie Mac Under Both Minimum and Risk-Based Capital Standards.'' News Release of December 30, 2002b.

Scholes, Myron S. ''Crisis and Risk Management.'' *American Economic Review* 90, no. 2 (2000), 17–21.

Stiglitz, Joseph, Jonathan, Orszag, and Peter, Orszag. ''Implications of the New Fannie Mae and Freddie Mac Risk-Based Capital Standard.'' *Fannie Mae Papers* 1, no. 2 (2002).

Szegö, Giorgio. ''Measures of risk.'' *Journal of Banking and Finance* 26, no. 7 (2002), 1253–1272.

Tuckman, Bruce. *Fixed Income Securities: Tools for Today's Markets*. 2nd edn, New York, John Wiley, 2002.

U.S. General Accounting Office. *Government Sponsored Enterprises: Federal Oversight Need for Nonmortgage Investments*. GAO/GGD-98-48, Washington DC, 1998.