The Interest Rate Risk of Fannie Mae and Freddie Mac

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Revised Version: July 31, 2002

1. **Introduction**

This paper evaluates the exposure of Fannie Mae and Freddie Mac (hereafter 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 size and status as US government sponsored enterprises (GSEs) raises special concerns.

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 US.[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 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 F&F would be unable to

maintain the full extent of these profit rates in a competitive environment.[3]

F&F's duopoly power is a key issue in this paper because this power has an impact on how

they manage their interest rate risk. Specifically, it is shown below that the profitability of the

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[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 Brent Ambrose and Arthur Warga [2002], Congressional Budget Office [2001a], Congressional Budget Office [2001b], W. Scott Frame and Larry D. Wall [2002a], and other papers cited therein. Current developments in 2002 to expand F&F financial disclosures are not considered in this paper, because their primary focus is not F&F interest rate risk or their interest rate disclosures.

[2] To be clear, I have no information that suggests F&F are violating US 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.

current F&F hedging strategy depends on this market power. It is also shown below that the F&F

hedging strategy leaves potentially large interest rate risks with the 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

the F&F interest rate risk that might potentially impose direct costs on US taxpayers.

The Business Lines of F&F

F&F operate in two distinct lines of business, <u>mortgage backed securitization</u> and <u>retained</u>

<u>mortgage portfolios</u>. 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 their 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 and, increasingly, repurchase 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. The figure also

shows that while Freddie Mac previously had quite a small retained mortgage portfolio, the

strategies of the two firms are now converging.

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[4] F&F do 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 small and is not considered further in this paper.

[5] By 2001, F&F were annually repurchasing about 50% of each year's newly issued MBS. By year-end
2001, F&F had retained approximately 33% of their total issued MBS, up from only 2% in 1991. These
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: Retained Portfolio relative to Investor-Held MBS Outstanding
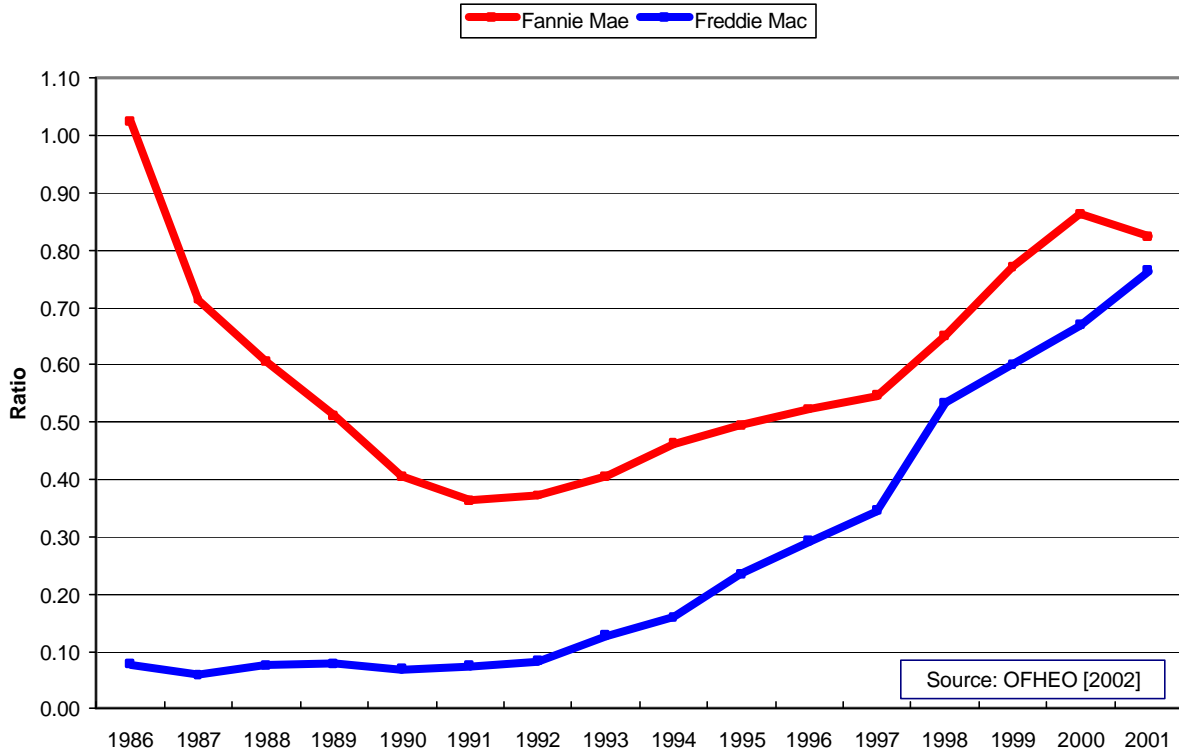

Figure 2: Primary Sources of F&F Profits
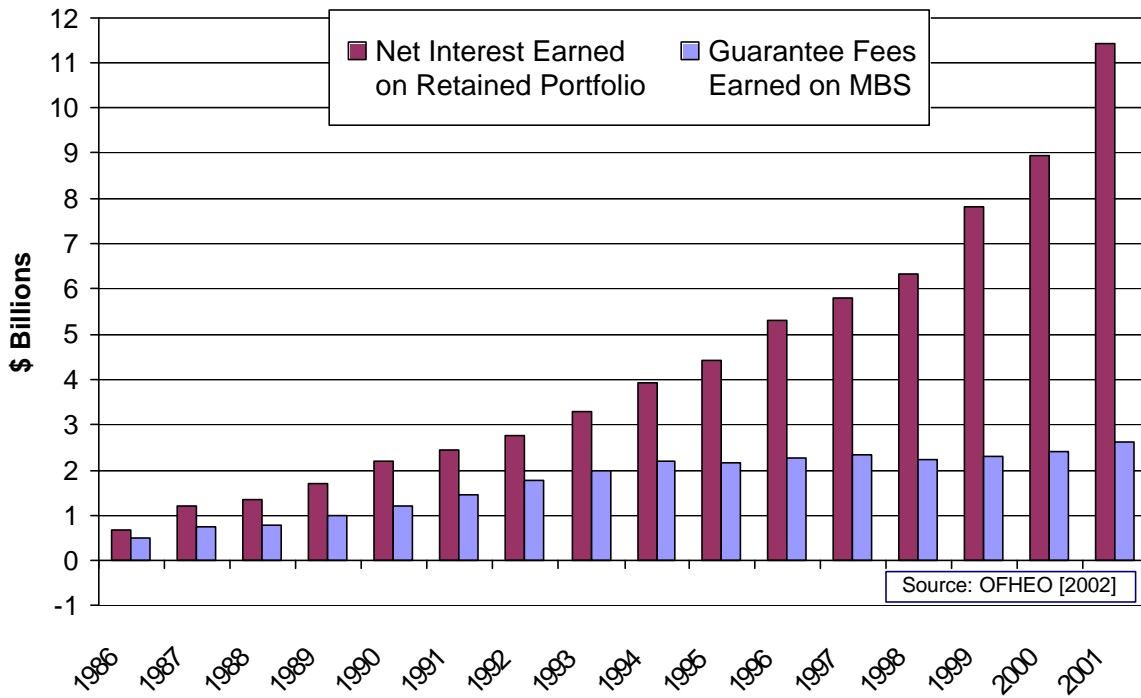**(FAS 133 effects removed in 2001)**

**Figure 3: Rate Spread on Retained Portfolio
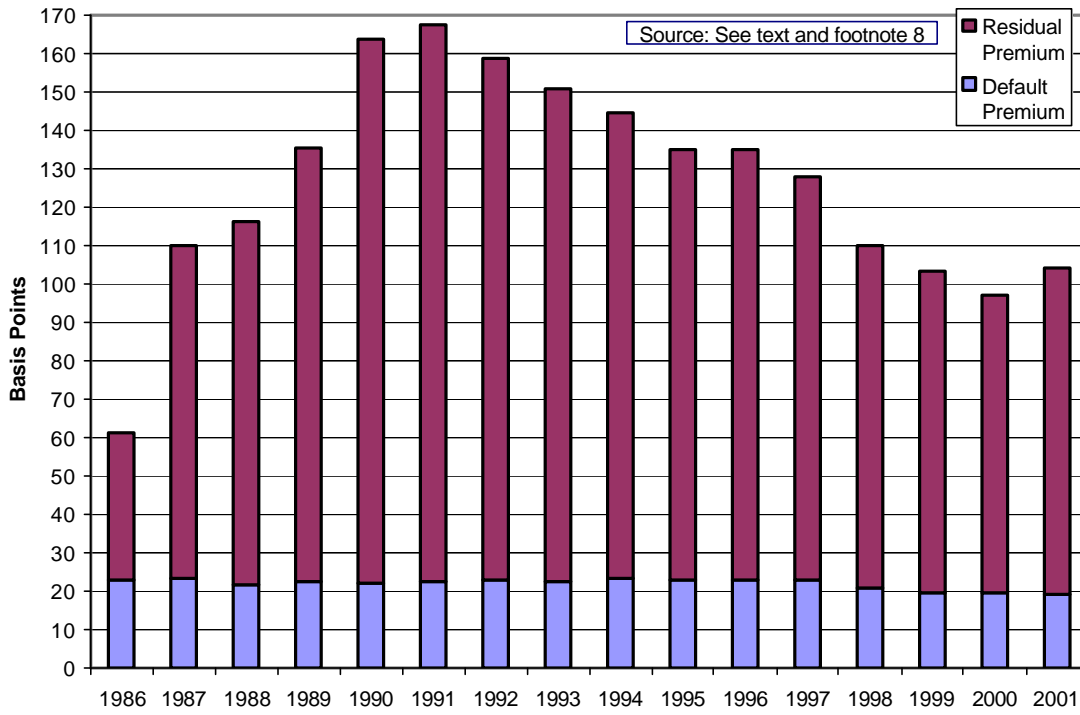By Component, in Basis Points**

Figure 4: Treasury Constant Maturity Interest Rates

The profit structures for the two F&F business lines differ substantially. Profits on the F&F investor-held MBS derive primarily from the annual guarantee fee they receive for guaranteeing the timely payment of interest and principal. Their average fee for the most recent year 2001 was 19 basis points (bp).[6] Profits on the retained 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 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:

(1) Retained Portfolio Rate Spread = Default Risk Premium + Residual Premium.

The default risk premium represents the compensation for 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 simply 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 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

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[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 annual report of the Office of Federal Housing Enterprise Oversight, OFHEO [2002].

[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 below. FAS 133 introduced new accounting rules for derivative securities beginning with 2001. The earlier system actually provided more economically meaningful accounts for firms such as F&F. 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.

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 very steadily since 1991. F&F have been able to achieve their rapidly rising retained portfolio profits (shown in Figure 2), in the presence of declining rate spreads, only by rapidly expanding the size of their retained portfolios (shown in Figure 1).

Decisions on new investments in the two business lines will depend on their returns on equity (ROE). Table 1 provides such data for the last five years, with ROE computed as income net of administrative expenses and taxes divided by regulatory capital.[9] It is apparent, for both Fannie Mae and Freddie Mac, that the retained portfolio ROEs substantially exceed the MBS ROEs, except for Fannie Mae in 1998. It is thus not surprising that we have observed F&F significantly expanding their retained portfolios relative to their MBS business in recent years. The generally higher Fannie Mae ROEs is related to their 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 leave no 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 imposing interest rate risks on US taxpayers, and, if so, what policy actions should be taken to rectify the situation.

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[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 [2002].

[9] The minimum capital requirements are .45% for the off-balance sheet MBS line and 2.5% for the on-balance sheet retained portfolio line. These values represent the binding constraints for F&F.

Table 1: Return on Equity by Business Line

Dollar amounts in Millions

	Retained Portfolio			Mortgaged Backed Securities		
A. Fannie Mae	Adjusted Operating Income	Average Regulatory Capital	Return on Equity	Adjusted Operating Income	Average Regulatory Capital	Return on Equity
2001	4904	16412	29.9%	804	3522	22.8%
2000	3749	14132	26.5%	667	3118	21.4%
1999	3243	11730	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	Adjusted Operating Income	Average Regulatory Capital	Return on Equity	Adjusted Operating Income	Average Regulatory Capital	Return on Equity
2001	2925	11924	24.5%	460	2751	16.7%
2000	2153	10575	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):

Excludes extraordinary items in all years.

Excludes FAS 133 adjustments in 2001.

Line allocations from Fannie Mae & Freddie Mac Information Statements, but

Mortgage backed security line earns guarantee fee only on investor-held MBS

Credit expenses are allocated by mortgage balances across the 2 lines.

Average regulatory capital (average of beginning and ending balance):

Equals 2.5% of retained portfolio,

Equals 0.45% of investor held MBS outstanding.

Return on Equity = Adjusted operating income/average regulatory capital

Data source: Fannie Mae and Freddie Mac Information Statements.

2. <u>Hedging the Interest Rate Risk on a Mortgage Portfolio</u>

I define a mortgage portfolio as the mortgage assets held together with 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 risk will be treated separately below. Also putting aside other (relatively minor) asset and liability items, we have:

(2) Mortgage assets = Bond liabilities + Equity

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 <u>market values</u> for their assets and liabilities, from which the <u>market value of equity</u> can be directly derived:

(3) Market value of equity = Market value of mortgage assets – Market value of bond liabilities.

<u>Sources and Measurement of Interest Rate Risk</u>

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 US 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-year 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 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.
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]

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[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, as we will see below, Fannie Mae regularly measures 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 is required to convey the same information.

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 match a corresponding liability cash outflow.

(2) Each optional mortgage cash inflow (i.e. prepayment) must match an optional liability cash outflow (i.e. call option).

F&F can meet these conditions by issuing a suitable array of long-term and callable bonds. I will call this a perfect balance sheet hedge. This is also sometimes called a perfect cash flow or zero maturity gap hedge, referring to traditional measures of hedge effectiveness in terms of the match between asset and liability cash flows or maturities respectively. I will refer to any interest rate risk that arises because the balance sheet hedge is imperfect as 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.[11] 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-term - short-term rate spread on F&F debt was about 250 bp.

2) Less than 20% of F&F assets are covered by callable debt, whereas fixed-rate mortgages with prepayment options equal about three-fourths of their retained portfolios. To create a perfect balance sheet, F&F would have to substitute more costly callable debt for non-callable debt.

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

Table 2: How F&F Finance Their Assets					
As of 12/31/2001					
Freddie Mac	$ Billions	% of Total Assets	**Fannie Mae**	$ Billions	% of Total Assets
Debt, within 1 year	250	**40.55%**	Debt, within 1 year	343	**42.95%**
Debt, after 1 year	312	50.48%	Debt, after 1 year	420	52.51%
Other liabilities	40	6.48%	Other liabilities	18	2.28%
Stockholders' equity	15	2.49%	Stockholders' equity	18	2.27%
Total Assets	617	100.00%	Total Assets	800	100.00%
Memo:			Memo:		
Callable debt	96	**15.63%**	Callable debt	140	**17.50%**
Fixed-rate Mortgages	433	**70.14%**	Fixed-rate Mortgages	664	**83.02%**
FRE, Information Statement, 3/29/2002			FNM, Information Statement, 4/1/2002		

Table 3: F&F Use of Interest Rate Derivatives					
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	Interest-rate swaps	300	-8.9
Option-based	408	5.2	Option-based	220	6.3
Other	201	0.0	Other	13	-1.5
Total	1,052	-0.8	Total	533	-4.1
Source: Fannie Mae [2002] and Freddie Mac [2002]					

Table 4: Yield Curves for Agency and Swap Markets			
Interest Rates as of June 6, 2002 Source: Fannie Mae web page			
Maturity	**F&F Agency**	**Swap Market**	**Difference**
1 year	2.45%	2.59%	-14 bp
2 year	3.32%	3.47%	-15 bp
5 year	4.68%	4.72%	-4 bp
10 year	5.59%	5.51%	+8 bp
30 year	6.38%	6.12%	+26 bp

Hedging Interest Rate Risk with Interest Rate Derivatives

Interest rate derivatives provide F&F an alternative means for hedging 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 underline interest rate swaps and underline option-based derivatives (in particular, underline swaptions). I now consider how these derivatives are used to hedge balance sheet rate risk, beginning with interest rate swaps.

The Profitability of Rate Swaps

F&F use interest rate swaps to convert short-term balance sheet debt into underline 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.

Interest rate swaps are a cost-effective mechanism for F&F to hedge their balance sheet rate risk if the yield curve in the swap market is flatter than the yield curve in the agency market for F&F bonds, which is usually the case. Table 4 shows, for example, that the rates on June 6, 2002 met this condition. To demonstrate why rate swaps are a cost effective hedging instruments for F&F, 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 directly issuing a 10-year agency bond was 5.59%. Alternatively, the swap strategy has the firm issue 1-year agency debt 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% (= 2.45% + 2.92%). The result is a saving of 22 bp (= 5.59% - 5.37%) relative to using the bond markets to complete a balance sheet hedge.

Rate Swap Arbitrage and F&F's Market Power

The yield curves in Table 4 would provide an attractive, risk-free, arbitrage for any investor with access to these markets. Specifically:

--borrow for 1-year in the agency market (-2.45%)

--invest for 10-years in the agency market (+5.59%)

--enter into swap to receive 1-year (+2.59%) and pay 10-year (-5.51%).

The transaction creates a sure profit of the same 22 bp we saw in the F&F hedging example.

Such arbitrage opportunities do not normally exist in active financial markets, since the very act of carrying out the arbitrage tends to eliminate it. Exceptions occur, however, if access to the arbitrage opportunity is highly restricted. This is precisely the case here, since only F&F (or other GSEs) have access to borrowing in the short-term agency bond markets (at 2..45% in the example). Private sector competitors, in contrast, would have to issue short-term commercial paper, and the higher interest rates in that market preclude a profitable arbitrage.

It is not necessarily a bad thing that F&F use their status as GSEs to hedge their interest rate risk at a very low cost. For example, if F&F access to low-cost hedging resulted in lower mortgage interest rates, this might be considered an effective policy mechanism. In practice, however, this does not seem to be the case. First, there is no apparent mechanism that would cause mortgage interest rates to change, either to rise or to fall, depending on how F&F hedge their interest rate risk. Second, it appears that F&F have the incentive and market power to retain a substantial amount of the saving from their hedging strategy. Specifically, the savings from low-cost hedging (22 bp in the example) are one likely source of the high residual premium (80 bp or higher in recent years in Figure 3), that F&F earn on their retained mortgage portfolio.

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 US taxpayers. In particular, <u>counterparty default risk</u>--the possibility that a counterparty would default on a contract and subject F&F to a loss--has received a great deal of attention. In my opinion, the danger due to this form of counterparty risk is 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 unlikely.

However, there is another, potentially larger, form of counterparty risk, that I will call <u>counterparty rollover risk</u>.. 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 be aware of F&F's need to renew its hedge positions and will try to take advantage of this in their pricing.

There is also one other form of rollover risk, what I will call <u>short-term debt rollover risk</u>. The source of this risk is the outstanding short-term debt that F&F must issue and roll over annually in conjunction with its use of interest rate swaps. Specifically, Table 2 shows that F&F must roll over more than 40% of their total bond positions each year. Debt rollover risk occurs if financial markets become severely disrupted, even for a reason unrelated to F&F, causing investors to 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.[12] However, Frame and Wall [2002b] have noted that if F&F were unable to sell new debt, then they may 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 will exceed 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.

Hedging Prepayment Risk with Swaptions

Just as F&F use interest rate swaps as an alternative to balance sheet hedging, they use a financial interest rate derivative called a swaption as an alternative to callable bonds to hedge interest rate risks created by the prepayment option on most fixed-rate U.S. mortgages. A swaption is an option on a swap contract. Since F&F are using swap contracts as a substitute for directly issued long-term debt, it makes sense that call options on swap contracts—that is, swaptions—can substitute for the call option that F&F would otherwise obtain by issuing callable bonds. The amount of swaption and related option derivatives in use by F&F are shown in Table 3 under the category "option based".

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[12] These are part of Freddie Mac's and Fannie Mae's "six voluntary disclosures"; see:
http://www.freddiemac.com/corporate/whois/commitments/index.html
http://www.fanniemae.com/initiatives/sixvoluntary/index.jhtml?p=Initiatives&s=Six+Voluntary+Initiatives

In principle, the profitability and risks of using swaptions in lieu of callable bonds could be analyzed as I just did for interest rate swaps. However, while F&F disclose the aggregate amount of their swaption positions, they do not disclose the very detailed information that is needed to evaluate the profits they earn and the risks they bear with respect to these instruments. Nevertheless, it is reasonable to assume that the situation for swaptions is very similar to that for swaps, namely that the instruments provide F&F with an effective and low-cost means for hedging as much of their interest rate prepayment risk as they wish.

The 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. I will call this component <u>dynamic hedging</u>. It involves 3 steps:

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

2) The further out in time, and the less likely the rate shock, the less complete the hedge.

3) As interest rate levels change, and the unlikely becomes more likely, implement additional interest rate hedges; hence the name dynamic hedging. [13]

The Risks of Dynamic Hedging

F&F employ dynamic hedging to save costs. In the absence of dynamic hedging, F&F would have to purchase interest rate derivatives to cover a wide range of extreme interest rate outcomes, each one 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

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[13] It has been suggested this is just traditional "delta" hedging, delta being the symbol used to denote the hedge ratio. However, the point here is that the initial hedge is intentionally incomplete, and the firm must also decide how and when to revise the hedge as conditions change. Although the technique is common, the academic literature appears limited with the exception of Leland [1985] and Leland [2000].

and far away dates. 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 dynamic hedging may reduce the hedging costs for a wide range of likely interest rate outcomes, the unlikely may still occur. In particular, a firm following a dynamic hedging strategy can suffer a large loss, 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 frequent updating of the hedge positions, but more frequent updating also eliminates the transaction cost savings that motivated the strategy in the first place.[14] Thus, dynamic hedging represents a trade-off, in which the firm accepts the interest rate risks associated with certain low-probability outcomes, in exchange for which it receives a substantial saving in transaction costs.

Going Short Interest Rate Volatility

The dynamic hedging employed by F&F also means that the firms are short, that is at risk with respect to, interest rate volatility. 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. The F&F dynamic hedging strategy leads to a short position in rate volatility because:

1) The F&F retained mortgage portfolios are at risk with respect to both falling interest rates (due to accelerating prepayments) and rising interest rates (due to the maturity mismatch).

2) Dynamic hedging provides imperfect protection against both rising and falling interest rates.

A short position in rate volatility is profitable for F&F, since it basically means that F&F are selling liquidity to the marketplace. F&F are very well positioned to provide such liquidity to the

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[14] 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.

market due to their GSE status. Going short liquidity generates profits on average, since firms in need of liquidity are willing to pay a price to obtain it. This provides a clear motivation for F&F to adopt this strategy. But, there is no free lunch. Being short volatility subjects F&F to the costs of financial distress created by a liquidity crisis. In the event of a serious and continuing liquidity crisis, the need for F&F to roll over as much as $500 billion of debt annually would become the most visible aspect of this financial distress.

The Cost of Completely Hedging the F&F Retained Mortgage Portfolios

Having seen that F&F are imperfectly hedging their interest rate risk, it would be useful to know what would be the cost for them to implement a complete hedge. Fortunately, a quantitative estimate of the cost of a complete hedge for the F&F retained mortgage portfolios can be derived by recognizing that F&F investor-held MBS and a retained mortgage portfolio *fully hedged against interest rate risk* are economically identical (assuming the underlying mortgages are identical). In both cases, F&F retain the mortgage default risk, but none of the interest rate risk. Consequently the rate of return should be the same for the two positions. However, as shown in Table 1, the ROEs that F&F earn on their retained mortgage portfolios are substantially higher than the ROEs for their MBS business line.

Table 5 provides a sample computation of the loss in income F&F would have incurred had they completely hedged their retained mortgage portfolios during the year 2001. The "actual" rows provide the data already shown in Table 1 for the year 2001. The "hedged" rows apply the ROE each firm earned on its MBS business line during 2001, assume no change in the amount of available capital, and then compute income as the product of the ROE and the capital. Complete hedging of its retained portfolio would have cost each firm about $1 billion in income, equal to from 24 to 32% of the income each actually earned on its retained portfolio.

Table 5: The Cost of Perfectly Hedging			
Adjusted Income for Retained Portfolio			
In $ Millions for the Year 2001			
	ROE	Capital	Income
Fannie Mae			
Actual	29.88%	16412	4904
Hedged	22.82%	16412	3746
Percentage loss			23.6%
Freddie Mac			
Actual	24.5%	11924	2925
Hedged	16.7%	11924	1994
Percentage loss			31.8%
Source: Derived from Table 1			

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:

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 dynamic hedging strategy, in which they primarily hedge the risks associated with the more probable interest rate changes. Dynamic hedging, however, also means imperfect hedging, whether based on balance sheet or derivative tools. A sample computation indicates that each firm would have foregone about $ 1 billion in annual income if it had completely hedged its interest rate risk.

We next turn to the disclosures provided by F&F that indicate the extent of their exposure to interest rate risk.

3. **Measuring the Retained Interest Rate Risk of F&F**

Retained interest rate risk is the amount of such risk remaining after taking into account a 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 specific hypothetical change in interest rates or interest rate scenarios. The models are used for two basic purposes, first to guide the firm's internal interest risk management, and second to disclose publicly how much interest rate risk remains unhedged. 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. In this part, I use these disclosures to evaluate the amount interest rate risk that is retained by F&F.

Freddie Mac's Retained Interest Rate Risk

Table 5 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, covering 50 bp and 100 bp shocks. The test measures the immediate resulting change in the book value of equity, but does not consider effects that would evolve only over 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.[15] 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 shock would have caused a 14% or $1.3

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[15] The yield curve is measured by the spread between the1-year 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.

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 indicate that it creates a much lower risk exposure than the 100 bp parallel shock.

A further aspect of Freddie Mac's interest rate risk is displayed 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 in the market value of equity. This indicates that the loss in market value of equity rises much more than proportionately as the size of the rate shock rises—in this case, 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. The key implication in the present circumstances 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 5 shows PMVS results that isolate the effect of interest rate derivatives in reducing Freddie's interest rate risk. The "before derivatives" results correspond to what I 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 5, except that the results in Part B are quarterly averages of tests made each day of the quarter. Although not displayed in Table 5, 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.

Table 5: Freddie Mac Retained Interest Rate Risk

Part A	Loss in Market Value of Equity Percent			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	1,031	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	1,300	n/a

Source: Freddie Mac, Information Statement, March 2002

Part B	Loss in Market Value of Equity Percent		
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%

Source: Freddie Mac, Information Statement, May 2002

Table 6: Fannie Mae Retained Interest Rate Risk

	Loss in Market Value of Equity 100 bp Shock Percent		Loss in Market Value of Equity 100 bp Shock $ Millions	
As of 12/31	rates rise	rates fall	rates rise	rates fall
2001	9%	23%	2168	5288
2000	2%	28%	473	5855

Note: includes change in the value of future guarantee fees

Source: Fannie Mae, Information Statement, April 2002

Fannie Mae's Retained Interest Rate Risk

Table 6 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. Freddie Mac, in contrast, 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 to 29%) Fannie Mae displays in the falling rate scenario.

It is a disappointing aspect of the Fannie Mae and Freddie Mac disclosures in Tables 5 and 6 that they cannot be directly compared as a result of these two points.

Fannie Mae also discloses two other measures of its interest rate risk. First, its "Effective Duration Gap" is a form of market value sensitivity measure, but is valid only for very small changes in interest rates (perhaps at the level of 5 or 10 bp). This instrument is used by Fannie Mae to monitor its interest rate exposure on a daily basis. Due to the issue of convexity, however, it is not a useful measure of Fannie Mae's interest rate risk for larger rate changes. Second, Fannie Mae discloses the impact of 100 bp shocks on the amount of net interest income that is lost (or gained) cumulatively, over both a one-year and a four-year horizon. This measure is also used by Fannie Mae in monitoring its interest rate exposure on a daily basis. But it has limited value for measuring the aggregate amount of Fannie Mae's interest rate risk, because it does not take into account the valuation changes that are created by cash flows beyond the four year horizon; see Frame and Wall [2000b] for a further critique of this Fannie Mae disclosure instrument.

Market Value Sensitivity versus VaR Disclosures

Frame and Wall [2002b] have proposed that F&F provide value-at-risk (VaR) rate risk disclosures, as used by many commercial banks. The market value sensitivity (hereafter MvS) measure already provided by F&F is similar to a VaR disclosure in that 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 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. Not coincidentally, the 50 bp and 100 bp rate shocks closely correspond to 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, but leaving 75 bp rate risks unhedged).

Frame and Wall advocate VaR because it will dependably reveal the true losses even in the presence of window dressing. This requires, however, that the published VaR results be truthful. At the same time, F&F, of course, deny any window dressing with respect to their MvS releases. In the end, protection against fraud will require active intervention by the F&F regulator, OFHEO. In the concluding section, I propose a system of random testing by OFHEO, and this is probably more conveniently carried out under the existing MvS system.

The OFHEO Stress Test

The Federal Housing Enterprises Financial Safety and Soundness Act of 1992 required

OFHEO to issue risk-based capital regulations for F&F to be enforced through a specified stress

test.[16] The stress test will be officially implemented for the first time in late 2002. The stress test

subjects F&F to rate shocks (relative to an average of the preceding 9 months), over a 10-year

period:[17]

1) The 10-year Treasury rate rises by 75%, constrained by a maximum permissible change of

600 bp. In the preliminary stress test reported in OFHEO[2002], the upward change was 371 bp.

2) The 10-year Treasury rate falls by 50%, constrained by a maximum decline of 600 bp. In the

preliminary test in OFHEO [2002], the downward change was 247 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.

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[16] 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 .

[17] 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 7: OFHEO Stress Test for March 31, 2002		
$ Billions	**Fannie Mae**	**Freddie Mac**
Risk-Based Capital Requirement		
High Interest Rate Scenario	18.475	5.680
Low Interest Rate Scenario	20.228	1.481
Minimum Capital Requirement[1]	24.571	19.39
Actual Capital	26.290	21.360
[1] = (.45%)(investor-held MBS) + (2.5%)(balance sheet assets)		
Source: OFHEO [2002]		

The test is made more severe by an assumed wave of mortgage defaults. The test currently also assumes that the firms do not put on any new business after the start date.[18] 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 ten years, plus an additional 30 percent to cover "operational risks". A firm is deemed to pass the test if its actual capital exceeds the computed risked based capital.

F&F have voluntarily subjected themselves to preliminary versions of the tests. Table 7 shows the results for a preliminary test carried out as of March 31, 2002, as reported in OFHEO [2002]. Both firms passed the test. Freddie Mac, in fact, passed by a huge margin, reflecting the firm's greater use of derivatives for hedging rate risk. Both firms lost some money in both the high rate 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 regime, suggesting its primary risk concerns mortgage prepayments, while Freddie Mac lost the most money in the high rate regime, suggesting it has a traditional maturity imbalance (borrow short, lend long).

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[18] 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.

The stress tests provide a highly useful complement to the voluntary interest rate sensitivity disclosures provided by F&F. In particular, many of the concerns raised by the dynamic hedging and short volatility strategies of F&F are answered, or are potentially answered, by the newly created tests. In particular, the stress test considers large rate shocks over a long time period, and does not allow the firms to update their hedge positions at all. However, in the concluding section which follows, I propose changes that would increase confidence that the stress test is measuring all relevant interest rate risk.

5. <u>Proposals and Conclusions</u>

This concluding section provides public policy proposals for disclosing and controlling F&F's interest rate risk based on the analysis of the paper. I start with proposals for modifying the interest rate disclosures provided by F&F, then consider the OFHEO stress test, and conclude with comments on interest rate risk standards for F&F.

<u>Modifications in Interest Rate Disclosures: Proposals for F&F</u>

The following 6 proposals are offered based on the preceding discussion of the interest rate risk disclosures of Fannie Mae and Freddie Mac:

1) Freddie Mac should disclose market value sensitivity results for rate changes in both directions, not just the direction of the greatest loss;

2) Fannie Mae should disclose market value sensitivity results with and without the effect of the change in guarantee fee income.

3) Fannie Mae should disclose its market value sensitivity results with and without the effect of its interest rate derivative positions.

4) 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.

5) Both Fannie Mae and Freddie Mac should disclose market value sensitivity results for a much wider range of interest rate shocks. This can be carried out using their current market value sensitivity systems, or under a value-at-risk (VaR) system.

6) 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 significant time lag relative to protect F&F confidentiality

Proposals (1) to (3) have the goal of creating direct comparability in the disclosures of the two firms. Proposals (4) to (6) call for expanded disclosures, although still within the spirit of what F&F are already providing.

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 Office of Federal House Enterprise Oversight (OFHEO). They are:

1) OFHEO should require standardized disclosures for F&F, consistent with the F&F proposals (1) to (3) above, to facilitate comparisons between the two firms.

2) FHEO should institute random testing of F&F interest rate sensitivity measures, 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 create and 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. Ad hoc methods can be very costly, as illustrated by the S&L regulator during the early 1980s.

Modifications in the OFHEO Stress Test

I have 4 proposals to improve our 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 U.S. 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 require 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) just above.

3) OFHEO should carry out and report continuing tests to validate its valuation model.

4) OFHEO should prepare operational plans for how it will respond were Fannie or Freddie to fail the stress test at some future date.

Interest Rate Risk Standards for F&F

The Congressional charters for F&F and related legislation have 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 any similar standards for the interest rate risk that F&F is allowed to accumulate.

The following factors motivate interest rate risk standards for F&F:

- 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 voluntary and reflects the expected profits that it creates.

- Mortgage borrowers receive no direct benefit when the F&F retained mortgage portfolios contain interest rate risk. The expected profits from such risky positions flow entirely to F&F shareholders.

- The F&F interest rate hedging strategies are focused on protecting their firms' capital resources against losses from frequently occurring interest rate changes. In contrast, the firms have not hedged against low probability interest rate scenarios from which the losses could far exceed their available capital resources.

- 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 US taxpayers.

Interest rate risk standards would be implemented by setting quantitative limits on the size of the retained mortgage portfolios that F&F could 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. The supply of funds for mortgage borrowers would be comparable to the current system, since F&F could continue to issue invested-held MBS under the same conditions that apply currently.

Concluding Comments

F&F should be commended for the voluntary interest rate disclosures they now provide. For the most part, the specific proposals I offer concerning rate risk disclosures are 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. I also propose a significantly more active role for OFHEO, to provide oversight of the F&F interest rate disclosures. Perhaps the most important proposal is for OFHEO to implement testing of the F&F interest rate disclosures over a wider range of interest rate shocks and at random dates.

The analysis also raised concerns for the overall level of the interest rate risk held by F&F as the result of their use of dynamic hedging. While dynamic hedging is highly cost effective, it provides no direct benefit to mortgage borrowers, and could impose significant costs on US taxpayers in terms of a potential future F&F bailout.

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