CHAPTER VI

COSTS OF HOUSING GOALS: CREDIT RISK

A. Introduction and Main Findings

This section discusses the costs that must be weighed against the benefits of the housing goals. One growing concern is the availability of credit to low-income borrowers and in underserved neighborhoods. While the potential unmet needs of these groups and the benefits of extending additional credit to them were discussed in Chapter IV, this chapter focuses on the additional cost and benefits associated with changes to the housing goals.

The primary cost is the risk of increased defaults on targeted loan purchases, as compared with the GSEs' total "baseline" expected purchases. The default potential of goals-oriented loan purchases will drive and dominate all other costs. Therefore, the discussion of costs that follows will focus on the additional mortgage credit risk associated with making loans to very-low- and low-and-moderate-income borrowers, and underserved neighborhoods. The analysis indicates that meeting the housing goals will have little impact on the GSEs' financial returns and on the safety and soundness of GSE operations.

The remainder of this section outlines the chapter and reports its main findings.

A.1. Outline of Chapter

Section B provides an overview of research on mortgage defaults focusing on three major areas of interest. First, Section B summarizes the substantial body of economic literature on determinants of mortgage default such as the loan-to-value ratio, borrower income, and the characteristics of the neighborhood where the property is located. Second, it summarizes the mortgage default analysis conducted by Office of Federal Housing Enterprise Oversight (OFHEO) as part of that office's examination of the capital adequacy of Fannie Mae and Freddie Mac. Finally, Section B examines the loan-to-value and credit characteristics of the GSEs' loans that satisfy the housing goals. Section C discusses lessons from the recent growth in affordable lending programs with particular emphasis on the risk characteristics of loans originated for lower-income borrowers.

Section D presents the model for estimating of the additional purchases under the final housing goals; the estimates from the model are discussed in Chapter III. Section E examines the impacts of the housing goals on the financial returns earned by the GSEs and discusses any implications for the safety and soundness of the GSEs. The impacts of the additional housing goal purchases on the GSEs' profitability are measured by examining their credit guarantee business. Section E also responds to concerns raised by Freddie Mac with HUD's profitability

analysis.

The profitability analysis enhances the model used for the 2000 GSE Rule in several key ways. It utilizes publicly available single-family and multifamily default and prepayment models and loss-severity assumptions from the OFHEO Regulation. This analysis uses GSE loan level data to estimate mortgages performance, loss severity, and ultimately cash flows for the GSEs' books of business.

The next subsection (A.2) presents the chapter's main findings, followed by a more detailed listing of specific findings concerning the impacts of the housing goals on the GSEs' credit costs and profits in subsection A.3.

A.2. Main Findings

There are six main findings from this chapter:

- While there is evidence that goals-qualifying loans have higher mortgage default rates than non-goals-qualifying loans, the additional mortgage default costs from goal-qualifying loans will have at most a modest impact on the expected financial returns earned by GSE stockholders.

- The GSEs will earn a reasonable financial return on the additional goal-qualifying loans that they must purchase in order to meet the new housing goals. The GSEs' expected return-on-equity (ROE) from goals-qualifying purchases is greater than the minimum required rate of return, or hurdle rate.

- HUD's past discussions with OFHEO as well as HUD's own analysis suggest that the new housing goals will not affect the sound financial condition and the safety and soundness of the GSEs. For the years 2000, 2001, 2002, and 2003 the GSEs have earned almost $41.7 billion in profits while financing nearly 20 million dwelling units that would qualify for the housing goals.

- Many of the goal-qualifying loans that the GSEs purchase have low risk characteristics. Loans to low- and moderate-income borrowers have low average loan-to-value ratios and rather high FICO scores, and a large portion of the loans purchased in low-income and high-minority census tracts are for borrowers with above-median incomes. In fact, there is increasing evidence that the income of the borrower is not nearly as important in determining mortgage defaults as other variables such as credit history and the loan-to-value ratio.

- The incremental default costs on borrowers and their neighborhoods will be limited due to the prudent nature of underwriting changes currently being made by the GSEs and the numerous other risk mitigating strategies now being employed by the GSEs and others in

the mortgage industry as they attempt to broaden their outreach to previously underserved groups.

- Recent studies of the financial return on mortgages are pointing out an offset to the credit risk typically associated with goals-qualifying mortgages—these loans prepay at slower rates during low-interest-rate periods, which increases their financial return.

- The market analysis in Chapters IV and V showed that there are large numbers of goals-qualifying loans available for the GSEs to purchase. Therefore, the GSEs can attract additional loans that qualify for the housing goals without overly relaxing their mortgage purchase and underwriting standards.

- Using the model developed in Section D, Chapter III provides estimates for each GSE of (a) the projected shortfalls in baseline goals performance from the new housing goal targets and (b) the additional purchases that will be needed to meet these shortfalls. That analysis shows that the GSEs' projected baseline performance (and particularly Freddie Mac's projected baseline performance) on the three housing goals falls significantly short of the new 2007 and 2008 goal levels. This will require Freddie Mac to reach further into the lower-income end of the mortgage market, which will lead to lower, but still reasonable, financial returns for Freddie Mac on its goals-qualifying purchases.

Essentially, the analysis shows that the GSEs are already purchasing goals-oriented mortgages in the course of their regular business. HUD's analysis shows that the additional purchases required to meet the new housing goals are expected to be profitable.

GSE Risk Mitigation Strategies. In its Economic Analysis for the 2000 GSE Final Rule, HUD emphasized that even if the additional loans required to meet the new housing goal targets have higher risk characteristics, on average, than current goals-oriented purchases, there are a number of risk mitigation techniques that the GSEs can use to lessen the increased risk. The GSEs are already using automated mortgage scoring systems to ensure that they do not purchase loans with multiple risk factors. According to research by Freddie Mac economists, a mortgage scoring system provides a better prediction of default probability than the traditional manual underwriting system; with this enhanced capability, Freddie Mac indicates that it can reach deeper into the low-income market. The GSEs are taking the lead in encouraging homebuyer education and loss mitigation as methods to control default risk. There is evidence that pre-purchase counseling and early delinquency intervention now practiced by the industry for high-LTV loans will reduce the risk of borrower default, and the move toward alternatives to foreclosure is lessening loss rates. In addition to these factors, the increase in credit cost to the GSEs is less than proportional to any increase in risk characteristics because mortgage insurance and other credit enhancements often cover the first loss on mortgage defaults. When entering new markets, the GSEs often do so by using structured transactions designed to limit their default losses, or by purchasing seasoned loans with a good payment record.[1] Thus, while there

[1] Freddie Mac used structured transactions to enter the subprime market; it purchased or guaranteed a relatively safe

may be some increase in mortgage defaults from expanding goals-oriented business, HUD concludes that there is no risk to the safety and soundness of GSE operations and that the GSEs will earn a reasonable economic return on their additional goal-qualifying purchases.

A.3. Summary and Specific Findings

This section summarizes analytical findings found throughout the rest of the chapter concerning the impact of the housing goals on GSE safety and soundness and on the financial returns earned by the GSEs.

a. Financial Model Results

HUD's specific findings regarding the potential credit costs and profitability of extending purchases to meet the three housing goals are:

- The GSEs already make goals-oriented purchases in the course of their ongoing operations. The relevant question here is the number and impact of the "additional" units required in order to meet the new regulatory targets—beyond those amounts that the GSEs would be expected to purchase without new housing goal targets (which are referred to below as "baseline" purchases). HUD's purchase model estimates the number of "additional" single-family and multifamily purchases each GSE would have to make under a variety of scenarios. While the model is described below in Section D, the results from this model are presented and discussed in Chapter III.

- The Urban Institute updated the financial model that it had developed for HUD as part of the 2000 Economic Analysis to examine the financial impacts of the new housing goals. The Urban Institute's analysis, which is summarized in Section E, reaches conclusions similar to its earlier analysis—that the GSEs can earn a reasonable financial return on their goals-qualifying purchases that is above their cost of capital.

- The additional loans purchased to meet the housing goals will have higher default costs, which will lead to a slightly lower financial return on the additional goal-qualifying loans as compared with baseline loan purchases.

- The financial return to the GSEs was examined under a variety of potential GSE purchase strategies and mortgage default environments. On baseline purchases (that is, projected GSE mortgage purchases in the absence of the new housing goals), the

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senior bond that was protected from default risk by a subordinated bond or other credit enhancements. Of course, as explained in Chapter IV, both GSEs have developed subprime-type programs of their own.

financial model estimates that the GSEs will earn returns on equity in excess of 25 percent, which is consistent with their experience in the past 10 years. Except under rather extreme mortgage default scenarios, the GSEs would earn a similar but slightly smaller financial return on their goal-qualifying purchases.

- The additional loans required to meet the housing goals are profitable enough to cover the GSEs' cost of capital. Return on equity is expected to meet or exceed the required rate of return (estimated at 15-17 percent) under most credit risk and economic stress scenarios.

- Section C.4e of Chapter III projects that Freddie Mac's baseline performance, in particular, falls significantly short of the out-year (2007 and 2008) goal targets. Assuming a normal home purchase environment, Chapter III projects that Freddie Mac will have to extend its reach into the lower-income end of the single-family market in order to reach the new goal and subgoal targets in 2007 and 2008. As explained in Chapter III, these additional purchase requirements will lead to lower, but still reasonable financial returns, for Freddie Mac. The staged increases in the goal levels should give Freddie Mac time to develop strategies to meet the out-year goal targets. While Fannie Mae will also have to improve its single-family performance to meet the out-year goals, its additional goals-qualifying purchase requirements are not nearly as large as those for Freddie Mac. Fannie Mae has to purchase less than Freddie Mac because its past performance has been better than Freddie Mac's, and thus, its projected baseline performance is higher than Freddie Mac's, which leads to Fannie Mae having smaller shortfalls from the new goal targets. While the estimates of additional purchases reported in Chapter III are "illustrative" and vary depending on initial assumptions, they provide a sense of the magnitude of additional goals-qualifying purchases. (See Sections C.4e-f of Chapter III.)

- Multifamily mortgages are much more likely than single-family mortgages to qualify for the housing goals.[2] Therefore, in HUD's purchase model, an important determinant of each GSE's goals performance is the share of total (combined single-family and multifamily) business accounted for by its purchases of multifamily loans. This percentage share—referred to as the "multifamily mix"— indicates a GSE's focus on multifamily business. While there are numerous single-family and multifamily purchase strategies that the GSEs could choose in order to meet the new housing goals, most are likely to involve an increased focus on "goals-rich" multifamily purchases. HUD projects that Freddie Mac will continue to increase its multifamily efforts, as a "multifamily mix" of 11-12 percent is consistent with

[2] About 90 (55-60) percent of newly-mortgaged multifamily units qualify for the Low-Mod (Special Affordable) Goal, compared with about 40 (15) percent of newly-mortgaged single-family-owner units. For this reason, multifamily purchases (as well as purchases of mortgages on single-family rental properties) are often referred to as being "goals rich".

Freddie Mac meeting the new housing goals under many of the purchase scenarios examined. Between 1997 and 1999, Freddie Mac's "multifamily mix" averaged about 8 percent, then increased to 9-10 percent during 2000 and 2001 before falling to 7.3 percent during the heavy refinance year of 2002. Freddie Mac's multifamily mix increased to 10.3 percent in 2003 due to bulk purchases of multifamily loans needed to meet the housing goals. Historically, multifamily has played a larger role in Fannie Mae's business than in Freddie Mac's business; Fannie Mae's "multifamily mix" was in the 10-13 percent range between 1997 and 2001, before falling to 7.3 percent during the heavy refinance years of 2002 and 8.0 in 2003.

- It should be emphasized that numerous strategies are available for the GSEs to meet the housing goals and that the purchase scenarios reported by HUD in Section D and Chapter III are purely illustrative. Still, the home purchase subgoals will play an important part in determining how the GSEs meet their overall housing goals. The additional purchases will be heavily weighted toward single-family home purchase loans that qualify for the three subgoals. Freddie Mac, in particular, will have to supplement its purchases of home loans with purchases of refinance, single-family rental, and multifamily rental loans in order to meet the final housing goals.

b. Risk Characteristics of GSE Purchases

There are several findings suggesting that past purchases of goal-qualifying loans by the GSEs did not involve particularly risky mortgages:

- Historically, moderate- and middle-income loans have the lowest overall default rates of all borrower income cohorts. In fact, Freddie Mac data show that low- and moderate-income loans have about the same default rate as other loans.

- Historically, a large percentage of the special affordable loans purchased by the GSEs have had loan-to-value ratios at or below 80 percent, which reduces their probability of default. In 2003, 50 percent of Fannie Mae's and 54 percent of Freddie Mac's purchases of special affordable home loans had a LTV ratio at or below 80 percent.

- A substantial portion of the loans in underserved areas that were purchased by the GSEs had low-risk characteristics. In 2001, 2002, and 2003, 50 percent of such loans had borrowers with incomes over the area median. In addition, about one-half of both GSEs' purchases of home loans in underserved areas between 1999 and 2003 had LTV ratios at or below 80 percent. A sample of GSE loans with credit score data suggest that over half of the GSEs' goals-qualifying home purchase loans have relatively high credit scores.

- From 1993 through 2003, the GSEs purchased $2,408 billion of Low- and Moderate-Income Goal qualifying mortgages. Likewise, between 1996 and 2003, Fannie Mae and Freddie Mac purchased $1,479 billion in mortgages from underserved areas and

$631 billion of special affordable loans. During this time period, Fannie Mae and Freddie Mac earned returns substantially higher than the returns earned by other institutions in the mortgage industry. Thus, the housing goals do not appear to have a negative effect on the GSEs' ability to earn profits.

c. GSE Risk Mitigation Strategies

The GSEs have demonstrated that they have the ability to manage the credit risk associated with purchasing additional goals-qualifying loans. They have become particularly adept at identifying, and avoiding, overly risky loans with multiple dimensions of risk. The following are examples of specific strategies they have used:

- *Automated Mortgage Scoring Systems.* From experience gained through use of their automated mortgage scoring systems, the GSEs reached such a level of confidence in identifying risk that they are now purchasing three percent down (97 percent LTV) loans.

- *Credit Enhancements and Recourse.* The GSEs utilize a variety of credit enhancements, for both single-family and multifamily mortgage purchases, to reduce the credit risk to which they might otherwise be exposed. For example, pursuant to their charters, the GSEs generally require the use of mortgage insurance on single-family loans with loan-to-value ratios exceeding 80 percent. Seller-provided credit enhancements such as recourse or loss-sharing agreements are often utilized in Fannie Mae's multifamily purchases. A GSE reduces its exposure through the use of agency pool insurance, which is often provided by a mortgage seller on a pool of single-family mortgage loans which may also individually carry mortgage insurance in order to achieve a lower guarantee fee.

- *Structured Transactions.* When purchasing new product types, both GSEs often use structured transactions to control their exposure to credit risk. Fannie Mae has utilized senior-subordinated structures to purchase seasoned pools of high-LTV loans without mortgage insurance originated by depositories as part of their compliance with the Community Reinvestment Act. Freddie Mac has used structured transactions to purchase A-minus loans.[3]

[3] In some structured transactions, a GSE may acquire a pool of loans, mortgage-backed securities (MBS), or real estate mortgage investment conduits (REMICs), and then create separate senior and subordinated securities, structured so that the subordinated securities absorb credit losses. The senior securities are guaranteed by the GSE; the subordinated securities are not. In other structured transactions, the GSEs acquire senior tranches of REMICs which are enhanced by the presence of subordinate tranches. These senior tranches typically receive an investment-grade rating from one of the major rating agencies. A difference between this type of transaction and the structured transactions described above is that when the GSEs purchase a senior tranche, the collateral is already credit-enhanced prior to purchase.

d. Recent Affordable Lending Efforts

In addition to the above strategies, Fannie Mae and Freddie Mac, along with other industry participants, have recently shown much innovation in limiting the possibility of default in funding mortgages for low-income families. Although it is too early to reach firm conclusions about the likely defaults from these new affordable lending programs, the following are some specific findings provided in Section C below regarding the credit risk of these programs:

- As discussed in Chapter IV, lenders, the GSEs, and private mortgage insurers have been offering new programs and implementing changes in mortgage marketing and underwriting that are extending homeownership opportunities to low-income families and their neighborhoods. This chapter discusses how the industry is attempting to control the credit risk on its new products. The new affordable initiatives are increasing the pool of potential loan purchases that are both sound investments and qualify under the housing goals.

- Still, there exists some uncertainty about how many of the recently-originated affordable loans will eventually default, particularly under economic conditions more adverse than have recently existed. This uncertainty will likely continue until it is determined how these loans perform through a complete economic cycle.

- The GSEs have been innovative in designing alternative underwriting standards that attract low-income, creditworthy borrowers and in developing mortgage scoring systems that identify as risky those loans with "layered" risk. The GSEs can meet the final housing goals and subgoals by continuing their careful approach of increasing the flexibility of their underwriting standards while at the same time using their risk-control techniques to ensure that they do not have to purchase overly risky loans. A wholesale relaxation of the GSEs' underwriting standards is certainly not needed to reach the final housing goals and subgoals.

- Other strategies used by the industry to control credit risk on low-income loans include pre-purchase and post-purchase counseling and proactive servicing of delinquent loans. The GSEs have been at the forefront in implementing these strategies. For example, each GSE has developed an automated system that helps their servicers identify the appropriate strategy for handling delinquent borrowers.

- This chapter reviews studies that provide information about the credit risks associated with flexible underwriting and the new affordable lending programs. Affordable lending will involve higher costs due to its higher delinquencies and greater servicing requirements. However, affordable lending programs can be profitable if they include: flexible underwriting with appropriate compensating factors (that is, avoiding situations of "layered risk"), homebuyer education programs, and effective loss mitigation programs.

- Mortgage borrowers receive many benefits from the GSEs' lower interest rates and homebuyer outreach programs, but a few of these borrowers will incur net costs due to the inability to maintain their homes over time. If foreclosures are concentrated in specific neighborhoods, they could have negative spillovers on other homeowners and mortgage investors. All of these costs are expected to be small because of the GSEs' continued ability to specify acceptable loan-to-value ratios, the expectation that underwriting standards will not be substantially lowered to meet the goal targets, and increased emphasis on homebuyer education and foreclosure avoidance throughout the mortgage industry.

e. Other Findings

There are several specific findings regarding the credit risk of the GSEs' multifamily purchases. These findings are discussed in greater detail in Chapter V:

- After satisfying the home purchase subgoals, multifamily purchases will be part of any strategy that Freddie Mac chooses to meet the new housing goals. This appears manageable, given that Freddie Mac has successfully re-entered the multifamily market and has substantially increased its multifamily purchases, from $6-7 billion between 1998 and 2000 to $12-13 billion in 2001 and 2002 and then rising to $22 billion in 2003.

- Both GSEs have implemented a variety of measures to successfully mitigate multifamily credit risk. These include widespread use of recourse and loss-sharing by Fannie Mae, and Freddie Mac's practice of re-underwriting each multifamily loan it acquires.

To summarize, while the additional goals-qualifying purchases will have higher default risk, the GSEs will not have to lower substantially their underwriting standards in order to increase their goals-related purchases. There is no evidence that the higher housing goals will require the GSEs to take on excessive risk. Rather, HUD believes that the GSEs can manage their credit risk on the goals-related purchases and can finance more low-income loans by continuing to improve their underwriting standards and outreach programs (as they and conventional lenders have been doing over the past six years) and by prudently entering new markets for affordable loans (as they have recently started doing).

B. Analysis of Credit Costs

To gain insights about the likely credit costs associated with goals-qualifying single-family loans, this section reviews what is known about why homeowners default on their mortgages. There have been numerous studies of this issue. However, one of the difficulties of predicting the risks of extending mortgage credit more widely to groups that have had limited

access in the past is that available information is based on a truncated sample. That is, only the default experience of loans that successfully passed previously used mortgage underwriting screens can be observed. If low-income and/or minority households behave differently than the households that have historically received most of the loans, previous experience may not be directly relevant. For this reason, Section C below examines the limited information that is available on recent affordable housing programs. It is also valuable to examine studies that have used FHA data because, historically, FHA has catered more to low-income and minority borrowers than the conventional mortgage market.

B.1. Mortgage Default Determinants: Loan and Borrower Characteristics[4]

The following discusses loan and borrower characteristics that past research has shown to be associated with defaults on types of mortgages that qualify for the housing goals.[5]

Equity Theory of Default. There is a broad consensus in the research community that negative equity is the single most important determinant of mortgage default and foreclosure. A homeowner in a negative equity position (that is, house value is less than mortgage balance) will be more likely to default on his or her mortgage obligation than a similar homeowner in a positive equity position. Early research in this area indicated that a very small percentage of homeowners with negative equity actually default.[6] This is, in part, because the costs of doing so (including damage to credit rating) are high. There generally must be an event, such as loss of income, a forced move or a divorce, which triggers default.

[4] Readers not interested in this general discussion of credit risk may want to proceed to Section B.3 which provides GSE specific data.

[5] Also see U..S. Department of Housing and Urban Development, (2000). *Economic Analysis for the Secretary of HUD's Regulation of the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac)*. Office of Policy Development and Research.

[6] Based on an analysis of Freddie Mac's mortgage defaults between 1975 and 1991, a 1992 HUD study found that about six percent of borrowers with negative equity tend to default. See "Appendix: Stress Test Analysis Techniques," in *1991 Report to Congress on the Federal Home Loan Mortgage Corporation*, Department of Housing and Urban Development, December 1992, pp. 120-176. For similar estimates based on FHA data, see Chester Foster and Robert Van Order, "An Option-Based Model of Mortgage Default," *Housing Finance Review*, Volume 3, No. 3, Fall 1985, pp. 273-291.

Credit History. In the past, a measure of borrower creditworthiness was an important variable missing from studies of mortgage default. This was unfortunate because credit scores are highly correlated with many variables that are typically included in default studies. For example, Avery, Bostic, Calem, and Canner (2002) find very distinct racial and locational patterns in the distribution of credit scores. First, African Americans and Hispanics have poorer credit history record than other borrowers. Second, median credit scores vary with measures of local economic conditions, for example, unemployment rates for census tracts are significant, suggesting that unemployment dynamics play a role in lowering the credit scores of individuals. Finally, credit scores vary across locationally, across regions and neighborhoods. Areas that show significantly lower credit scores are census tracts with a high percentage of people living in poverty, with high minority populations, with low median incomes, with low house values, and where a large percentage of the population hold high school diplomas.

Increasingly data on the credit history of individual borrowers are being incorporated into research on mortgage default and loss experience. Studies of FHA data find that credit history is an important determinant of FHA foreclosures and loss severity.[7] Borrowers with poor credit histories have higher probability of default and higher costs than their counterparts with better credit histories.[8] Credit history plays an important role in many of the conventional mortgage industry's special lending programs; these programs often require a good credit record before relaxing other underwriting variables such as the loan-to-value ratio or the payment-to-income ratio.

Initial Loan to Value (LTV) Ratio. Studies that include the initial LTV ratio show a positive relationship between LTV and default rates. LTV ratio directly determines the initial equity position of the borrower. The equity theory of default implies that a high loan-to-value ratio will lead to increased risk of default. Studies of both FHA and the GSEs default experience shows that as LTV ratios exceed 75 percent, default probability increases. A study by Deng and Gabriel (2002) estimate that the cumulative default probability for FHA loans at the end of three years is 3.28 percent for FHA loans with LTV ratios greater than or equal to 95 percent compared to 2.56 percent for FHA loans with LTV ratios less than 95 percent.[9] Another study by Calhoun and Deng (2002) looks at the GSEs' default experience on 30-year fixed rate

[7]Harold L. Bunce, William J. Reeder and Randall M. Scheessele, "Understanding Consumer Credit and Mortgage Scoring: A Work in Progress at HUD". U.S. Department of Housing and Urban Development, Unpublished Paper, (June 30, 1999). Also see Cotterman (2002).

[8] Robert Cotterman, "New Evidence on the Relationship between Race and Mortgage Default: the Importance of Credit History Data" study prepared for Office of Policy Development and Research, U.S. Department of HUD, May 23, 2002. This study also found that controlling for credit history reduced or eliminated the effect of borrower race on defaults.

[9]Yongheng Deng and Stuart Gabriel, "Modeling the Performance of FHA-Insured Loans: Borrower Heterogeneity and the Exercise of Mortgage Default and Prepayment Options," prepared for Office of Policy Development and Research, U.S. Department of HUD, February, 2002.

mortgage. It estimates that loans with LTV ratios between 90 and 100 percent are 2.5 times more likely to default than loans with LTV ratios between 75 and 80 percent.[10]

Payment-to-Income Ratio. The monthly mortgage payment-to-income ratio is an underwriting variable that is being relaxed in many of the new community lending programs. Economic theory suggests that a high monthly payment-to-income ratio should increase the likelihood of default, but empirical studies have produced mixed results. HUD's 1995 Economic Analysis reported findings from several studies that have examined the payment-to-income ratio—many finding that it was a significant determinant of mortgage default and but some finding that it was not.

Borrower Income. A recent study by Van Order and Zorn (2002) modeling competing risk of mortgage termination (and more specifically the embedded put option related to default) indicates that borrower income is an important determinant in whether or not a homeowner with negative home equity will actually default.[11] This study finds that default and loss severity are higher on loans of lower income borrowers. One reason lower-income borrowers are more likely to default compared to higher income households is that they have fewer economic resources to weather trigger events such as unemployment or divorce. Also on average, mortgages on smaller house values incur higher transaction costs associated with foreclosure.

In earlier research the relationship between borrower income and default probability was more ambiguous. Some studies found default probability to decline as income increases while others found default rates to be lowest for moderate- and middle-income borrowers and highest for both low- and high-income borrowers. As with most analyses of borrower characteristics relative to default, the focus, by necessity is usually on borrower income at the time of origination. Obtaining income at the time of default would require an expensive survey design.

While few studies have focused directly on income level, a larger number have included proxies for income stability and growth (such as occupation, income from commissions, self-employment, and length of employment), or wealth measures. Measures associated with income variability are fairly consistently associated with default risk. Self-employed borrowers, those with income from commissions or investments, and those with low-skilled jobs are more likely to default, apparently due to their higher probability of experiencing reduced income. A number of studies have found that borrowers with lower levels of liquid assets, or other non-housing wealth, have higher default rates.

[10]Charles A. Calhoun and Yongheng Deng, "A Dynamic Analysis of Fixed- and Adjustable-Rate Mortgage Terminations, *Journal of Real Estate Finance and Economics*, 24: 9-33, 2002.

[11]Robert Van Order and Peter Zorn, "Performance of Low-Income and Minority Mortgages," in *Low-Income Homeownership: Examining the Unexamined Goal*, Joint Center for housing Studies and Brookings Institution Press, 2002.

Loan Size. Both PMI (private mortgage insurance) data and FHA data show a pattern of higher default rates for loans at the small end of the spectrum. The pattern observed for small loans may be reflecting the limited liquid assets and/or unstable incomes of those who take out small mortgages. It could also be reflecting the higher volatility of house prices in the rather "thin" market for low-priced houses.

First Time Homebuyers. Evidence on the default risk of first-time homebuyers is limited and mixed. Analyses of FHA loans find the default rate to be higher for first-time homebuyers in some origination years, but not others, when other borrower and loan characteristics were controlled.

Minority Borrowers. As credit history of borrower has become available, the impact of race on default has become less important. An analysis of borrowers with FHA mortgages found that after controlling for credit history, the coefficient for race was significantly reduced or eliminated and that the default experience for African-American borrowers was no worse than whites.[12] Another study looking at both low-income and minority borrowers using fixed-rate mortgage purchased by Freddie Mac had a similar finding: most of the default differences between low-income, minority and other loans were explained by observable characteristics such as the downpayment and the credit history of the borrower.[13]

OFHEO Default Model. OFHEO's final risk-based capital rule includes several of the above-listed variables in its mortgage default model for GSE loans. The OFHEO model used historical loan performance data from the GSEs to estimate separate models of single-family default and prepayment behavior for three different loan products: (1) a model for 30-year fixed-rate mortgages (FRMs); (2) a model for adjustable-rate mortgage (ARMs); and (3) a model for other (OTHER) FRM loans, including balloon loans, 15-year FRMs, 20-year FRMs, and government loans.[14] All of the models estimate quarterly joint probabilities of default and prepayment conditional on the age of the loan and other explanatory variables.[15]

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[12]Robert Cotterman, "New Evidence on the Relationship between Race and Mortgage Default: the Importance of Credit History Data" study prepared for Office of Policy Development and Research, U.S. Department of HUD, May 23, 2002.

[13]Robert Van Order and Peter Zorn, "Performance of Low-Income and Minority Mortgages," in *Low-Income Homeownership: Examining the Unexamined Goal*, Joint Center for housing Studies and Brookings Institution Press, 2002, p. 324.

[14]12 CFR Part 1750 Office of Federal Housing Enterprise Oversight; Risk-Based Capital, Federal Register, Vol. 66, No. 178, pp. 47730-47875, Thursday, September 13, 2001; and Federal Register, Vol. 67, No. 177, pp. 57760-577767, Thursday, September 12, 2002.

[15]The quarterly probabilities are converted to monthly default and prepayment probabilities for projecting mortgage cash flows in the OFHEO's Risk Based Capital stress test. The explanatory variables (discussed in text) are coded as categorical variables. The models for ARMs and other loans are modified versions of the baseline 30-year FRM model and are explained in more detail in Appendix B to this chapter. For example, the ARM model is estimated on a pooled sample of 30-year FRM and ARM loans, but includes additional variables specific to the performance of ARM loans relative to that of 30-year FRM loans. The OTHER model is estimated on a pooled sample of 30-year

The following explanatory variables are used:

- Mortgage Age. Defaults and prepayments increase during the first years following loan origination, and then peak between the fourth and seventh years.

- Probability of Negative Borrower Equity. Borrowers with negative equity are more likely to default than those with positive equity. The probability of negative equity is affected by housing prices and loan amortization, but also includes a stochastic element.

- Interest Spread (between the mortgage note rate and current mortgage market rates). This is a measure of the borrower's incentive to refinance, and prepayment probabilities are consequently an increasing function of the spread.

- ARM Payment Shock. The ARM payment shock is an interaction term between the relative spread variable just discussed and an indictor of an ARM loan to distinguish the impact of changes in market rates on ARM and FRM loans.

- Early ARM Payment. This is an indicator of early ARM payments for ARM loans seasoned less than 12 quarters (3 years). This accounts for the potential impact of changes in the ARM coupon from a low initial ("teaser") rate to the fully-indexed rate (index plus margin) over the first years of the loan

- Burnout. If a borrower has passed up previous opportunities to refinance at favorable interest rates, such a borrower is considered less likely to refinance, and more likely to default.

- Yield Curve Slope. The yield curve reflects interest rate expectations. To the extent that interest rates are expected to rise in the future, a borrower has an incentive to refinance. To the extent that interest rates are expected to fall, a borrower has an incentive to wait before refinance.

- LTV at time of origination. Default probability is an increasing function of LTV, while prepayment probability is a decreasing function.

- Occupancy status. Default probabilities are greater, and prepayments are lower, on non-owner occupied than owner-occupied properties.

- Product Type Indicators. There are four product type indicators to account for the performance of non-standard loans relative to the standard 30-year FRM loan type:

FRM loans and the other loan types, and includes variables to measure their performance relative to 30-year FRM loans.

BALLOON, 15-Year FRM, 20-Year FRM, and GOVERNMENT.

- Benchmark Calibration Factors. This relates the rates of mortgage default applied in the RBC stress test to the historically high default rates that occurred in their historical benchmark experience.

Appendix B to this chapter provides a complete discussion of the OFHEO model.

Mortgage Scoring Systems. In recent years, the GSEs, private mortgage insurers, FHA, and many major lenders have employed automated mortgage scoring systems to approve mortgage loan applications. In 2000, Fannie Mae published the 14 factors it uses to make a loan decision. The three most important factors are down payment, credit performance and financial cushion (such as cash reserves). The other 11 are borrower's debt-to-income ratio, whether a borrower is self-employed, loan term, loan type (i.e., fixed-rate, adjustable-rate, or balloon), number of units in the dwelling, building type (i.e., cooperative, condominium, or attached), are there funds from other parties coming into the loan, loan type (home purchase or refinance), number of borrowers, whether borrower has prior bankruptcies and foreclosures, and number of prior mortgage delinquencies.

During the mid-to-late nineties, automated underwriting systems became the predominate mortgage underwriting method and revolutionized the mortgage financing process completing mortgage approvals in days compared to weeks under the manual mortgage underwriting. The majority of Fannie Mae and Freddie Mac's mortgage purchases are approved using their respective automated underwriting systems, Desktop Underwriter and LoanProspector, as well as a larger percentage of FHA-insured loans. (See Section G.1 of Chapter IV for a discussion of the GSE's automated underwriting systems.)

B.2. Determinants of Mortgage Defaults: Neighborhood Determinants

The mortgage default rate in underserved areas is a specific concern for the GSE housing goals. HUD received several comments concerning the impact of mortgage default rates on neighborhoods. Comments from mortgage insurance companies highlighted that the higher goals will likely lead to more expanded affordable housing products as well as higher foreclosures. These affordable products present challenges to borrowers and lenders. As defaults on affordable products rise, inner city neighborhoods can be especially hard hit, according to the commenters. A large number of foreclosures in an area may lead to abandoned properties and weaken the neighborhoods where the properties are located through serious blight and disinvestments in the community.

The GSEs and community groups cautioned that the struggle to meet high goals for targeted groups could cause the GSEs to relax underwriting standards and/or extend loans to people who are unprepared. For example, the commenters pointed out that FHA default rates are higher than the conventional conforming market. High goals would encourage the GSEs to enter

markets served by FHA. This incentive to extend credit to unprepared low-income people would rise if unexpected refinances decreased the proportion of goals-eligible units produced in the market.

The Department believes that the GSEs' presence in underserved markets will be beneficial for neighborhoods. The GSEs have improved their underwriting methods to better identify risks in these markets, and also have instituted homebuyer education programs. Greater availability of prime credit will reduce the costs of mortgages and the chances of default in inner-city neighborhoods, which today often depend on higher-cost subprime lenders for credit. As a result, the Department believes that GSE participation is a net benefit to underserved neighborhoods, as traditional mainstream lenders will more likely service these neighborhoods if there is an active secondary market present.

Based on mortgage default studies cited in HUD's 1995 and 2000 Economic Analyses, there are three insights from earlier research on the influence of neighborhood characteristics on mortgage default behavior. *First*, simple bivariate comparisons show that default rates are higher in minority neighborhoods and in those neighborhoods with lower incomes. *Second*, both FHA and Freddie Mac data suggest that lower-income neighborhoods have higher expected credit risk than higher-income neighborhoods, even after controlling for loan-to-value ratio, borrower income, and other characteristics. *Finally*, a major study by the Federal Reserve of the impact of neighborhood characteristics on the credit risk of mortgage lending reached mixed conclusions.[16] The 1993 Federal Reserve study examined the risks associated with lending to low-income and high-minority neighborhoods. Its findings lacked definitive conclusions regarding neighborhood credit risk.[17] Despite relatively high mortgage default rates, the earlier empirical research did not prove or disprove that minority or low-income neighborhoods were any more risky than predominantly white or high-income neighborhoods, once individual loan and borrower characteristics such as the initial loan-to-value ratio and borrower income were accounted for. But as reviewed below, there have been some recent studies with controls that have found higher default rates in low-income and minority neighborhoods.

The following part of this section reviews recent literature on mortgage delinquency and default experience. These studies fall into two categories. The first considers the impact of borrower credit history in examining delinquency, default, and loss rates. The second examines house appreciation for affordable loans.

Performance Research. Quercia et. al. (2002) examine the potential market for community lending portfolio products for purchase by Government Sponsored Enterprises such

[16] Board of Governors of the Federal Reserve System, *Report to the Congress on Community Development Lending by Depository Institutions*, 1993.

[17] The 1993 Fed Study found that (1) the risks and returns on lending are related to many factors. Neighborhood characteristics are less important than other factors, (2) the relationship between both neighborhood income and neighborhood racial composition and lending risk is unclear, and (3) the risk of neighborhoods may not affect lender profitability.

as Fannie Mae and Freddie Mac. The only risk factor that they find that significantly affects ninety-day delinquency rates among their sample of community reinvestment loans is the borrower's credit score, and that impact is quite large. After controlling for credit scores, neither loans with extremely high LTV or high back-end ratios, nor the layering of factors displays any greater risk. However, this lack of statistical significance may have been due to the lack of variation in loan-to-value and back-end ratios among the loans in their sample. The cure rate for delinquencies is high, even among loans with the lowest borrower credit scores. Finally, gender is the only borrower characteristic that significantly affects delinquency risk, with male borrowers approximately 2.5 times more likely to experience extended delinquency than female borrowers.[18]

Cotterman (2001) examined whether default of FHA-insured loans is traceable to the separate influence of locational factors and borrower characteristics, including past credit performance. More specifically, the study examines the effect on the default of FHA-insured loans of neighborhood characteristics, including the median income and the racial or ethnic composition of the census tract. The study finds that loans originated in census tracts with low median incomes and a high percentage of blacks are associated with higher default probabilities, even after controlling for the race, ethnicity, and credit history of the borrower. There are no significant individual borrower race effects, either black or Hispanic, or borrower income effects on default probability. Causes for these findings are explored, and the effects are reduced when other variables are included in the analysis, such as lagged defaults and prepayments and neighborhood house price change. Lagged neighborhood defaults, which measure past default activity in a particular neighborhood, appear to lead to lower price growth in the neighborhood.[19]

The probability of default is only one dimension of costs associated with foreclosure. Cotterman (2003) investigates the interaction of default and conditional loss rate based on a sample of FHA-insured loans. Loss rates decline with increases in time-to-default and rise as the time spent to complete foreclosure and property disposition increases. The study finds that, although there is a link between factors affecting default probabilities and those affecting loss rates, there are differences in the relative importance of factors affecting each. FICO scores appear to be more important in determining default behavior, while house price growth and

[18]This study also evaluates the early default performance (within 24 months of purchase) of a sample of portfolio loans by Self-Help Ventures as part of its Community Advantage™ (SHCA) Home Loan Secondary Market Program. The loans are Community Reinvestment Act (CRA)-type mortgages, which allow for low borrower credit scores, low or no down payment, high debt-to-income ratios, and no mortgage insurance. The study assesses the impact on performance of four risk factors that potentially influence the potential market for community lending products. These risk factors include credit scores, loan-to-value ratios, back-end ratios, and reserve requirements. Loan performance is assessed by measuring the incidence of ninety-day delinquency, both first-time and ever, less than ninety-day delinquency, more than ninety-day delinquency, and termination.

[19]The impact on individual prepayments is unclear. Introducing housing price growth measures and lagged default and prepayment rates substantially reduces the effects of neighborhood income and of the fraction of the neighborhood that is black. While the neighborhood income effect is still significant, the neighborhood race effect no longer is.

relative house price appear to be more important in affecting loss rates.[20] Blacks, Hispanics, and mortgage on houses in judicial foreclosure states and in underserved areas have higher loss rates than do FHA loans that do not have these features.

Studies on House Price Appreciation. The impact of changing house prices on defaults is important for a number of reasons. First, an important factor in determining the probability of negative equity is changes in house prices. The probability of negative equity has been found to be the main time varying covariate influencing a borrower's mortgage default decision.[21] Second, as house prices fall, the severity of loss rises in the event of a default. Default losses increase non-linearly and faster than the decline in house prices.[22] For purposes of this economic analysis, an important question concerns the relative house price appreciation of homes purchased by low-income families or in underserved areas. This section first reviews early research on this issue, and then reviews more recent research.

Earlier research on house appreciation found the low-cost and high-cost housing markets are separate and therefore shifts in demand and supply in one market will not affect the other market. Pollakowski, Stegman and Rohe (1992) found that low-cost homes appreciated in price equally as well as other types of homes in five MSAs. Seward, Delaney and Smith (1992) found that low-cost homes appreciated in value more slowly in St. Petersburg, Florida from 1973-1987 during expansions, but depreciated in value at comparable rates to high-cost homes during contractions. Kiel and Carson (1990) offered a somewhat contradictory conclusion; high and low-cost homes appreciated at higher rates than those in the middle range from 1974-1983. Smith and Ho (1996) provided some explanation of the seemingly contradictory results of past studies. They suggest that price differentials between low and high-cost homes are dependent in part on monetary and fiscal shocks. Specifically, prices for high-cost homes are sensitive to changes in economic factors such as inflation while prices for lower-cost homes are more sensitive to changes in interest rates, income and employment. In short, patterns of profit and loss emerge depending on variation in these economic factors. Other authors, including Li and Rosenblatt (1997), and Case and Shiller (1994) attribute differences in price appreciation to market segmentation in low- and high-cost housing.

The remainder of the section focuses on recent studies that examine the house price appreciation associated with affordable loans. The first study, Case and Marynchenko (2002), examine price appreciation for houses deemed affordable to low-income people at the time of purchase, regardless of where they are located. In contrast, the second, Belsky and Duda (2002), analyze home price appreciation and equity accumulation in low-income neighborhoods. Belsky

[20]The back-end ratio significantly affected the probability of default but had little impact on loss rates.

[21]John Quigley, Robert Van Order, and Yongheng Deng, "The Competing Risks for Mortgage Termination by Default and Prepayment in Residential Housing Markets," paper presented at the NBER Summer Institute 1993, Cambridge, Mass.

[22]Karl Case and Robert Shiller, "A Decade of Boom and Bust in the Prices of Single-Family Homes: Boston and Los Angeles: 1983-1993." *New England Economic Review* (March 1994), p. 40-51.

and Duda (2002) conclude that in the four MSAs they studied, house purchases that were affordable to low-income households experienced greater price appreciation and lower risk of losses upon resale. Case and Marynchenko (2002) provide the more tentative conclusion that while homeownership has allowed low-income homebuyers to realize comparable and even greater appreciation in home value than other types of homebuyers, this trend varies significantly by place and time of purchase.

Belsky and Duda (2002) examine matched pairs of low-cost housing transactions from 1982-1999 in Boston, Chicago, Denver, and Philadelphia. Low-cost housing is defined as housing affordable to those earning 80 percent or less of the area median income, with area median incomes assessed at the level of the metropolitan statistical area (MSA). The data include only homes bought and sold during the study period and therefore the sample disproportionately represents shorter holding periods. The authors find that losses on resale are actually less common and less severe for low-cost housing than for other types of housing. Owners of low-cost units were more likely than other owners to sell at a profit during market upswings, but less likely to sell at a loss during downturns. Although this trend has reversed recently, low-cost homes made up a greater share of the homes purchased during a trough than a peak. They attributed this finding to differences in housing price cycles between the groups and also the timing of purchases and sales.

Case and Marynchenko (2002) examine home price appreciation in low income neighborhoods from 1983-1998. Specifically, the authors analyzed repeat sales prices indexes at the zip-code level, produced by Case Shiller Weiss Inc., for Boston, Chicago, and Los Angeles. Zip-codes were divided into quintiles based on median incomes within that zip-code. The data include observations from 1983-1998 in Boston, from 1987-1998 in Chicago, and from 1983-1998 in Los Angeles. Overall, the results show that the financial benefits of home purchase for low-income people vary significantly based on the year of home purchase and the location. In particular, the findings show that prices in the bottom decile in Boston increased at a real annual rate of 16 percent from 1983-1988, declined by 8.2 percent from 1989-1992, and declined by 0.5 percent from 1992-1998. In contrast, prices in the bottom decile in Chicago increased by 6 percent from 1987-1992, and increased by 4 percent from 1992-1998. Prices in the bottom decile in Los Angeles increased by 6 percent from 1983-1990, declined by 10 percent from 1990-1993, and declined by 3 percent from 1993-1998.

This study finds that homeownership as a vehicle for asset accumulation for low-income households is mixed. All households purchasing homes in Chicago in 1987 and those purchasing homes in Boston in the early 1980s have experienced house price growth. The value of equity for buyers of all income levels purchasing homes in 1995 increased in all three cities from 1995-1998. This is not the case for households purchasing homes in Boston in the late 1980s and in Los Angeles in the early 1990s. These homeowners experienced negative equity from falling house prices where households in low-income neighborhoods experienced greater declines than higher-income neighborhoods. Homeowners who needed to sell their properties during these periods faced substantial losses with greater losses for homeowners in lower-income neighborhoods.

A recent study by the Joint Center for Housing studies (March 2002) finds that house prices in CRA-eligible neighborhoods increase more rapidly and resist declines better than in higher-income neighborhoods.[23]

B.3. Some Data and Issues Specific to the GSEs

a. Loan-to-Value Ratios

The ratio of the loan value to the property value, or loan-to-value (LTV) ratio, is a major factor in mortgage underwriting guidelines. Downpayment requirements reduce moral hazard by increasing the borrower's share of the credit risk. As discussed earlier, it is well established in the literature that there is a high degree of correlation between the size of down payments and the frequency of defaults. Somewhat surprisingly, studies have found that there is not always a close link between low-income borrowers and high-LTVs, that is, many low-income borrowers take out mortgages with high downpayments.[24] Bunce and Scheessele (1998), Manchester (1998), and Bunce (2000, 2002) found that about half of the low-income loans purchased by Fannie Mae and Freddie Mac had LTVs less than 80 percent. Canner et al. (1995 and 1996) found evidence that the GSEs buy proportionately fewer high-LTV loans than are made by mortgage lenders.[25]

The purpose of this section is to examine the LTV characteristics of GSE loan acquisitions. The loan-to-value ratio has a direct impact on the amount of credit risk Fannie Mae or Freddie Mac would be exposed to. The amount of the required downpayment also affects the affordability of a mortgage loan. Therefore, does increasing their affordable lending acquisitions require the GSEs to absorb more credit risk? Tables 6.1 to 6.6 provide LTV information on the GSEs' purchases between 2001 and 2003, as do Tables A.28 and A.29 in Appendix A. The material below mainly draws from Tables A.28 and A.29.

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[23] *The 25th Anniversary of the Community Reinvestment Act: Access to Capital in an Evolving Financial Services System*, prepared for the Ford Foundation by the Joint Center for Housing Studies, Harvard University, March 2002, p 74.

[24] See Robert Van Order and Ann B. Schnare, "Finding Common Ground," *Secondary Mortgage Markets*, Volume 11, No. 1, Winter, 1994, p. 1 and pp. 15-17; Paul R. Allen and Robert Van Order, "High-LTV Lending", *Secondary Mortgage Markets*, Winter, 1991/92, pp.20-23; Bunce, Harold L. and Randall M. Scheessele. 1998. *The GSEs' Funding of Affordable Loans: A 1996 Update*. Working Paper No. HF-005. Office of Policy Development and Research, U.S. Department of Housing and Urban Development, (July); Manchester, Paul B. 1998. *Characteristics of Mortgages Purchased by Fannie Mae and Freddie Mac: 1996-97 Update*. Working Paper No. HF-006. Office of Policy Development and Research, U.S. Department of Housing and Urban Development.

[25] Canner, Glenn B. and Wayne Passmore. 1995. "Credit Risk and the Provision of Mortgages to Lower-Income and Minority Homebuyers." *Federal Reserve Bulletin*, (November), 989-1016 and Canner, Glenn B., Wayne Passmore and Brian J. Surette. 1996. "Distribution of Credit Risk among Providers of Mortgages to Lower-Income and Minority Homebuyers." *Federal Reserve Bulletin*, (December), 1077-1102.

TABLES 6.1 – 6.6

Overall Trends. The GSEs (and particularly Fannie Mae) have recently increased their purchases of home purchase loans with low downpayments. After remaining about 4 percent of Fannie Mae's purchases between 1997 and 2000, over-95-percent-LTV loans jumped to 7.1 percent during 2001, 7.7 percent during 2002 and 11.5 percent in 2003. As a share of Freddie Mac's purchases, over-95-percent-LTV loans increased from 1.1 percent in 1997 to 5.9 percent in 2000, before falling to 4.3 percent in 2001, 4.8 percent in 2002 and 4.7 percent in 2003. If the low-downpayment definition is expanded to ten percent (i.e., over-90-percent-LTV loans), Freddie Mac had about the same percentage (25 percent) of low-downpayment loans during 2001 as Fannie Mae. In fact, under the more expansive definition, Freddie Mac had the same share of over-90-percent-LTV loans in 2001 as it did in 1997 (about 25 percent), while Fannie Mae exhibited only a modest increase in the share of its purchases with low downpayments (from 23.2 percent in 1997 to 25.4 percent in 2001). The share of over-90-percent-LTV loans in Freddie Mac's purchases fell sharply from 25.0 percent in 2001 to 21.9 percent in 2002 and 19.9 percent in 2003, while the share in Fannie Mae's purchases fell more modestly from 25.4 percent in 2001 to 24.2 percent in 2002 before rebounding to 25.3 percent in 2003.

LTVs of Goal-Qualifying Loans. A large percentage of goals-qualifying loans purchased by the GSEs have high downpayments. For example, 54.3 percent of special affordable home loans purchased by Freddie Mac during 2003 had a downpayment of at least 20 percent, a percentage that was not much lower than the high-downpayment share (59.5 percent) of all Freddie Mac's home loan purchases. Similarly, 49.8 percent of the home loans purchased by Fannie Mae in underserved areas during 2003 had a twenty percent or higher downpayment, compared with 54.6 percent of all home loans purchased by Fannie Mae.

The fact that approximately half of the goals-qualifying loans purchased by the GSEs have a downpayment of over twenty percent is consistent with the GSEs' minimal service to minority first-time homebuyers, who experience the most problems raising cash for a downpayment.

Less-Than-5-Percent Downpayment Loans. Both GSEs introduced programs allowing very low downpayments (LTV greater than 95 percent) during 1998.[26] After the first full year, 1999, of these programs, the data indicate that there was an increase in very high-LTV loans purchased by the GSEs. Fannie Mae purchased 107,287 and 128,295 95-plus LTV home purchase loans during 2001 and 2002. During 2003, Fannie Mae purchased 220,127 very-high LTV home purchase loans, more than four times the 51,855 very high-LTV home purchase loans purchased in 2000. Freddie Mac's purchases of the 95-plus LTV home purchase loans increased

[26]Fannie Mae introduced its "Flexible 97" and Freddie Mac introduced "Alt 97" during 1998. Under these programs borrowers are required to put down only three percent of the purchase price. The down payment, as well as closing costs, can be obtained from a variety of sources, including gifts, grants or loans from a family member, the government, a non-profit agency and loans secured by life insurance policies, retirement accounts or other assets.

Table 6.1

GSEs' Single-Family Owner-Occupied 1-Unit Home Mortgage Acquisitions
2003

	Meets 1 or More Affordable Housing Goals					
	Fannie Mae			Freddie Mac		
Loan-to-Value Ratio	No	Yes	Total	No	Yes	Total
0% < LTV <= 80%	3,385,777	3,356,630	6,742,407	2,218,211	1,785,730	4,003,941
	87.1%	80.6%	83.7%	88.0%	80.8%	84.6%
80% < LTV <= 90%	299,101	408,585	707,686	180,861	228,777	409,638
	7.7%	9.8%	8.8%	7.2%	10.4%	8.7%
90% < LTV <= 100%	198,689	393,675	592,364	104,673	144,475	249,148
	5.1%	9.5%	7.4%	4.2%	6.5%	5.3%
Missing	4,673	6,637	11,310	17,437	51,213	68,650
	0.1%	0.2%	0.1%	0.7%	2.3%	1.5%
Total	3,888,240	4,165,527	8,053,767	2,521,182	2,210,195	4,731,377
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: National File A.

Table 6.2

GSEs' Single-Family Owner-Occupied 1-Unit Home Mortgage Acquisitions
2002

	Meets 1 or More Affordable Housing Goals					
	Fannie Mae			Freddie Mac		
Loan-to-Value Ratio	No	Yes	Total	No	Yes	Total
0% < LTV <= 80%	2,003,733	1,944,482	3,948,215	1,635,804	1,415,449	3,051,253
	82.8%	75.2%	78.9%	84.0%	76.3%	80.3%
80% < LTV <= 90%	239,282	327,240	566,522	184,034	244,936	428,970
	9.9%	12.7%	11.3%	9.5%	13.2%	11.3%
LTV > 90%	173,184	308,316	481,500	117,081	168,207	285,288
	7.2%	11.9%	9.6%	6.0%	9.1%	7.5%
Missing	2,986	4,487	7,473	9,510	26,865	36,375
	0.1%	0.2%	0.1%	0.5%	1.4%	1.0%
Total	2,419,185	2,584,525	5,003,710	1,946,429	1,855,457	3,801,886
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: National File A.

Table 6.3

GSEs' Single-Family Owner-Occupied 1-Unit Home Mortgage Acquisitions
2001

	Meets 1 or More Affordable Housing Goals					
	Fannie Mae			Freddie Mac		
Loan-to-Value Ratio	No	Yes	Total	No	Yes	Total
0% < LTV <= 80%	1,435,289	1,377,965	2,813,254	1,118,893	998,439	2,117,332
	77.1%	71.6%	74.3%	78.9%	72.7%	75.8%
80% < LTV <= 90%	239,116	274,615	513,731	160,847	185,178	346,025
	12.8%	14.3%	13.6%	11.3%	13.5%	12.4%
LTV > 90%	186,791	270,471	457,262	136,946	180,890	317,836
	10.0%	14.0%	12.1%	9.7%	13.2%	11.4%
Missing	890	2,377	3,267	2,157	9,473	11,630
	0.0%	0.1%	0.1%	0.2%	0.7%	0.4%
Total	1,862,086	1,925,428	3,787,514	1,418,843	1,373,980	2,792,823
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: National File A.

Table 6.4

GSEs' Single-Family Owner-Occupied 1-Unit Mortgage Acquisitions
2003

	Fannie Mae				Freddie Mac			
Loan-to-Value Ratio	All	Low-Mod	Special Affordable	Underserved	All	Low-Mod	Special Affordable	Underserved
0% < LTV <= 80%	6,742,407	2,592,708	855,744	1,519,035	4,005,495	1,352,907	427,003	794,917
	81.4%	79.7%	77.7%	78.6%	83.4%	80.4%	79.6%	79.0%
80% < LTV <= 90%	707,687	309,641	96,597	205,194	413,016	172,752	54,856	113,562
	8.5%	9.5%	8.8%	10.6%	8.6%	10.3%	10.2%	11.3%
LTV > 90%	592,364	321,266	123,460	194,848	282,259	112,248	35,810	70,590
	7.2%	9.9%	11.2%	10.1%	5.9%	6.7%	6.7%	7.0%
Missing	240,635	30,904	25,595	14,428	104,500	44,098	18,765	26,685
	2.9%	0.9%	2.3%	0.7%	2.2%	2.6%	3.5%	2.7%
Total	8,283,093	3,254,519	1,101,396	1,933,505	4,805,270	1,682,005	536,434	1,005,754
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: National File A.

Table 6.5

GSEs' Single-Family Owner-Occupied 1-Unit Mortgage Acquisitions
2002

	Fannie Mae				Freddie Mac			
Loan-to-Value Ratio	All	Low-Mod	Special Affordable	Underserved	All	Low-Mod	Special Affordable	Underserved
0% < LTV <= 80%	3,948,215	1,499,992	492,829	883,189	3,051,253	1,070,468	354,517	656,371
	78.9%	75.5%	74.8%	72.2%	80.3%	76.3%	75.9%	73.8%
80% < LTV <= 90%	566,522	243,822	78,110	173,545	428,970	181,231	61,285	132,235
	11.3%	12.3%	11.9%	14.2%	11.3%	12.9%	13.1%	14.9%
LTV > 90%	481,500	240,151	86,883	164,958	285,288	129,246	42,356	85,599
	9.6%	12.1%	13.2%	13.5%	7.5%	9.2%	9.1%	9.6%
Missing	7,473	3,488	1,284	2,255	36,375	21,776	8,917	14,887
	0.1%	0.2%	0.2%	0.2%	1.0%	1.6%	1.9%	1.7%
Total	5,003,710	1,987,453	659,106	1,223,947	3,801,886	1,402,721	467,075	889,092
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: National File A.

Table 6.6

GSEs' Single-Family Owner-Occupied 1-Unit Mortgage Acquisitions
2001

	Fannie Mae				Freddie Mac			
Loan-to-Value Ratio	All	Low-Mod	Special Affordable	Underserved	All	Low-Mod	Special Affordable	Underserved
0% < LTV <= 80%	2,813,254	1,040,000	340,738	650,521	2,117,332	758,780	246,063	457,020
	74.3%	71.5%	72.4%	70.0%	75.8%	72.9%	72.5%	70.2%
80% < LTV <= 90%	513,731	202,120	57,775	139,284	346,025	136,872	41,718	95,343
	13.6%	13.9%	12.3%	15.0%	12.4%	13.2%	12.3%	14.6%
LTV > 90%	457,262	209,873	71,421	138,949	317,836	136,852	46,976	94,053
	12.1%	14.4%	15.2%	14.9%	11.4%	13.1%	13.8%	14.4%
Missing	3,267	2,003	1,003	1,172	11,630	8,289	4,488	4,845
	0.1%	0.1%	0.2%	0.1%	0.4%	0.8%	1.3%	0.7%
Total	3,787,514	1,453,996	470,937	929,926	2,792,823	1,040,793	339,245	651,261
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: National File A.

from 6,456 in 1997 to 54,543 in 2000 before tailing off to 43,787 loans in 2003. While very high-LTV home purchase loan acquisitions increased as a percent of overall purchases over the period 1999 to 2003, they still represent a small portion of the GSEs' home purchase loan acquisitions (11.5 percent for Fannie Mae and 4.7 percent Freddie Mac). The 95-plus LTV share of goals-qualifying home purchase loans acquired by Freddie Mac decreased by more than half between 2001 and 2003. The 95-plus LTV share of Special Affordable purchases decreased from 12.3 to 3.8 percent; Low-Mod decreased from 8.6 to 3.5 percent; and Underserved Areas decreased from 8.1 to 3.2 percent.

Both Fannie Mae and Freddie Mac have taken a conservative approach to purchasing high-LTV loans. For example, 97-LTV loans are required to go through the GSEs' automated underwriting systems to prevent the layering of risk. Preventing the layering of risks is a key objective in the GSEs' credit risk management. The objective is to prevent multiple negative credit risk indicators (such as low downpayments, poor credit scores and high debt ratios) which significantly increase the likelihood that a loan will experience severe credit problems down the line. As they gained more experience with the risk characteristics of these loans and with the use of automated mortgage scoring systems, the GSEs expanded their interest in high-LTV loans. But given their conservative approach, any marginal increase in high-LTV loan acquisitions is not expected to have a significant impact on credit risk.

Underserved Areas. One issue of particular importance is the potential credit risk of loans in underserved areas. Many of the underserved area loans that have been purchased by the GSEs are low-LTV mortgages. For example, in 2003, 49.8 percent of Fannie Mae's and 53.6 percent of Freddie Mac's single-family owner-occupied 1-unit home purchase mortgage acquisitions from underserved areas had an LTV less than or equal to 80 percent. Freddie Mac's underserved areas acquisitions with an LTV greater than 90 percent decreased from 34 to 22 percent of eligible loans between 2001 and 2003 and their 95-plus loan acquisitions decreased from eight to three percent of eligible loans. Over the same period, Fannie Mae's acquisition of high-LTV, 95-plus LTV, underserved area loans increased from 12 to 19 percent. In addition, GSE purchases of loans from underserved areas are mainly from moderate- or high-income borrowers. During 2002, 47 percent of all of Fannie Mae's and Freddie Mac's underserved area single-family owner-occupied 1-unit home purchase mortgage acquisitions had a borrower income greater than the area median income. Thus, there is a heterogeneous mix of loans purchased from underserved areas, which suggests that any increase in credit risk is modest.[27]

b. Credit Scores and GSE Purchases: A Preliminary Look[28]

[27]GSE Public Use Database

[28]The analysis is labeled "preliminary" because of issues related to the representativeness of the sample data. See the notes in Table 3.5 of Chapter III for further explanation of the FICO scores, in particular, for caveats concerning the representativeness of the data.

The GSEs tend to purchase loans with higher FICO scores than other segments of the mortgage market. Sixty-one percent of the GSE's acquisitions of home purchase loans in 12 selected metropolitan areas between the years 1998 and 2000 had a FICO score greater than 720, while 51 percent of non-GSE purchased conventional conforming loans were 720+ score and only 21 percent of FHA insured loans were that high. As shown in Figure 6.1, the distribution of conventional conforming home purchase loans, both GSE-purchased and non-GSE, are skewed toward higher FICO scores. The FHA distribution includes a greater percentage of lower FICO scores.[29] The average FHA FICO score was found to be 642, while the average score for a non-GSE conventional conforming loan was 703 and the average GSE score was 725. Figure 6.1 shows that the GSEs tend to purchase higher credit-quality loans than what is in either the non-GSE portion of conventional conforming market or the FHA market.

See Table 3.8 in Chapter III for the FICO score distributions of the GSEs' purchases of home loans under each of the housing goals categories, for the years 1998 to 2000. For example, from Table 3.5, 14.3 percent of special affordable loans purchased by the GSEs had a FICO score below 620, compared with 9.8 percent for all their home loan purchases. While 60.7 percent of all home loans purchased had a FICO score greater than 720, only 54.9 percent of special affordable, 57.1 percent of low- and moderate-income, and 51.2 percent of underserved area loans had high FICO scores. However, note that these differentials do not appear to be particularly large, and that over half of goals-qualifying loans had a FICO score in excess of 720. The latter point—over half of goals-qualifying loans having a FICO score over 720—is a similar finding to the earlier finding that about half of goals-qualifying loans have LTV ratios less than 80 percent. Combined, these findings suggest that there is not much credit risk associated with many of the GSE- purchased loans that qualify for the housing goals.

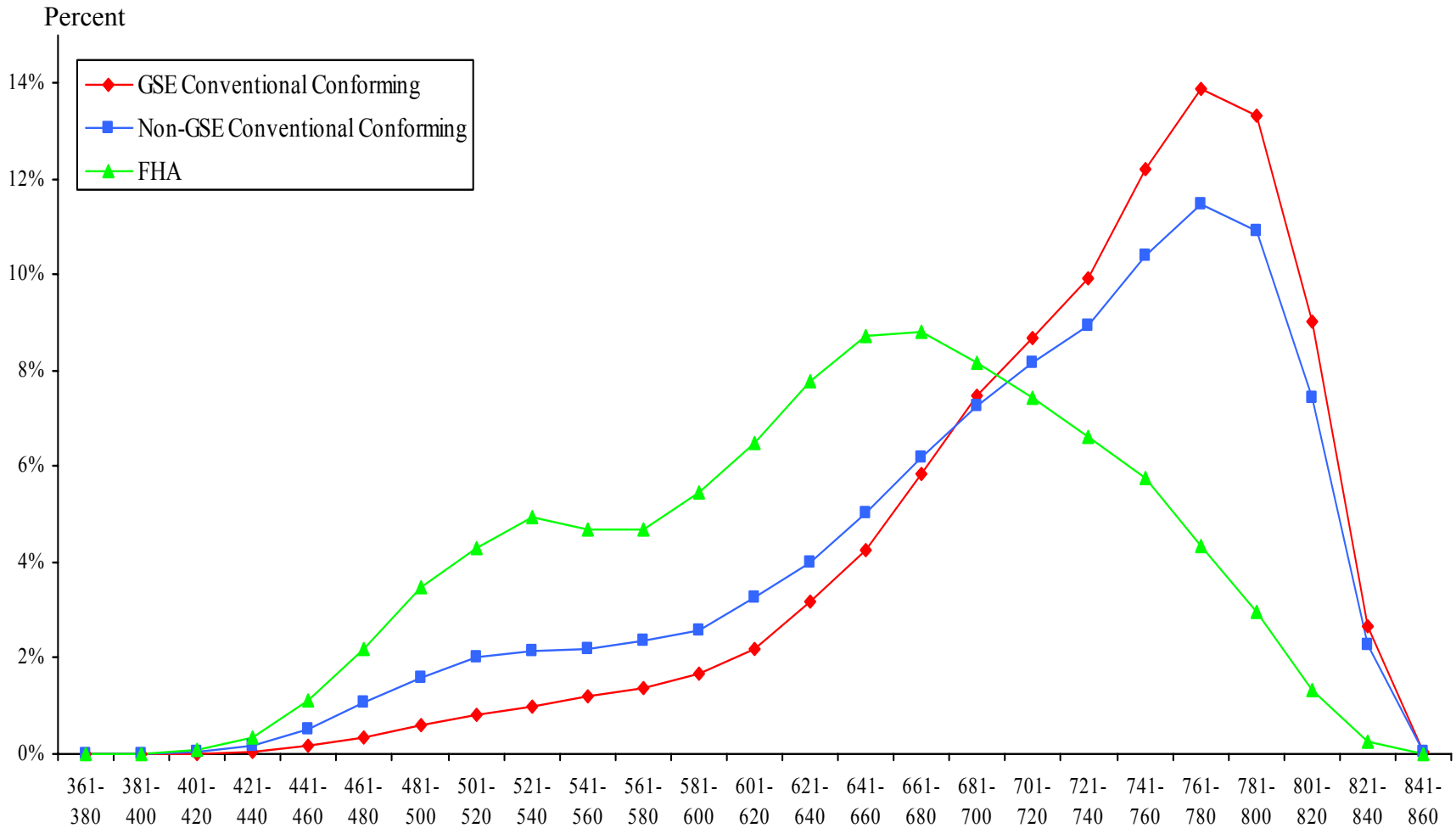
B.4. Historical Credit Performance

Credit losses have risen for both GSEs in 2003.[30] Fannie Mae incurred $111 million, or 0.006 percent of its average total mortgage portfolio, in credit losses during 2003. In the years prior to 2003, credit losses fell. Fannie Mae's credit losses were $69 million in 2002 (0.004 percent), down from $76 million (0.005 percent) in 2001, and $85 million (0.007 percent) in 2000. This compares to Freddie Mac's credit losses of $82 million (0.007 percent) in 2003, $74 million in 2002 (0.007 percent), $45 million (0.005 percent) in 2001, and $66 million (0.008 percent) in 2000.

[29]The bi-modal characteristic of the FHA distribution appears to be an aberration of the Experian data used in this analysis.

[30]All credit loss and delinquency data for Fannie Mae and Freddie Mac are obtained from their respective annual reports to stockholders for 1999, 2000, 2001, 2002, and 2003. Freddie Mac's credit loss and delinquency data for 2003 were obtained from Freddie Mac's information statement supplement for June 30, 2004 entitled Freddie Mac 2003 Financial Results. It can be found on its website www.freddiemac.com/investors/infostat/index.html. Freddie Mac's 2003 Annual Report has not been made available to the public.

Figure 6.1
Analysis of GSE, Non-GSE, and FHA FICO Scores



Delinquency rates for both Fannie Mae and Freddie Mac have crept up since 2000. Over the period 2000 through 2003, Fannie Mae experienced 0.45, 0.55, 0.57, and 0.60 percent serious delinquency rates, respectively, on its single-family portfolio. Similarly Freddie Mac's delinquency rates for single-family over that same time period was 0.49 percent in 2000, 0.62 percent in 2001, and 0.77 percent in 2002.[31] Fannie Mae's multifamily portfolio serious delinquency rates were 0.07 percent in 2000; 0.27 percent in 2001; 0.05 percent in 2002, and 0.27 percent in 2003. This compares to 0.04 percent in 2000, 0.15 percent in 2001, 0.13 percent in 2002, and 0.05 percent for 2003 for Freddie Mac's multifamily portfolios.

C. Credit Risk and Termination Risk of Recent Affordable Lending Programs

C.1. Affordable Lending Products

The most distinguishing characteristic of affordable lending is the use of nontraditional flexible underwriting guidelines. There is evidence that the use of flexible underwriting guidelines based on risk-mitigating mechanisms need not pose greater risk than the use of traditional or standard guidelines. As explained in Chapter IV, flexible underwriting guidelines are important because they help address barriers faced by borrowers with wealth constraints and poor credit. Affordable lending product may include layering risk factors, alternative measures of creditworthiness, waived or reduced cash reserves, and waived or reduced mortgage insurance. Homeownership education and counseling may be required in order to qualify for an affordable lending program.

In recent years, the GSEs' have embraced an alternative underwriting criteria for affordable lending products based on compensating risk factors rather than layering risk. This is based on their belief that loans underwritten using multiple nontraditional guidelines are at significantly greater risk of delinquency and default (Quercia, 1999). Where layering risk relaxes one of the underwriting criteria of the standard product, compensating risk factors loosens one factor while tightening another.

Table 6.7 provides a comparison of some factors used in underwriting loans for different mortgage products demonstrating the nontraditional and flexible underwriting guidelines of affordable lending products currently available to nontraditional borrowers. Compared to the standard mortgage, affordable lending products aimed at helping wealth-constrained borrowers allow lower down payments, higher debt burden limits, lower credit score, lower availability of cash reserves, and alternative evidence of creditworthiness. Some examples include Freddie

[31] Freddie Mac's single-family delinquency data for 2003 are available in Freddie Mac's information statement supplement for June 30, 2004 entitled Freddie Mac 2003 Financial Results. It can be found on its website: www.freddiemac.com/investors/infostat/index.html. The Freddie Mac 2003 Financial Results report does not provide the delinquency rate for Freddie Mac's overall single-family business in 2003, but rather provides separate rates for its non-credit-enhanced portfolio (0.27 percent) and its credit-enhanced portfolio (2.95 percent). Freddie Mac's 2003 Annual Report has not been made available to the public.

Mac's Affordable Gold 5, Affordable Gold 3/2, Affordable Gold 97, Affordable Gold Alt 97 and Freddie Mac 100.

TABLE 6.7

Each GSE has a flow product available to borrowers with credit blemishes. Fannie Mae offers Expanded Approval with Timely Payment Rewards while Freddie Mac offers the Affordable Merit Rate mortgage. These products have an automatic rate reduction built into the contracted interest rate. For example, under Timely Payment Rewards, the borrower will automatically receive a note rate reduction of up to one percentage point after 24 consecutive months of "timely payments" (no 30-day delinquency) within the first four years of the loan. This product encourages these borrowers to improve their creditworthiness.

Primary lenders have also developed a number of experimental products to reach nontraditional borrowers. Lenders mainly hold these loans in portfolio because they do not follow the GSEs guidelines.

While flexible underwriting guidelines need not pose greater risks than the use of traditional or standard guidelines if risk-mitigating mechanisms are used, the evidence for affordable loan products is mixed. Some studies reported positive experience while others reported negative experience (Quercia 1999). There is some consensus however that the determinants of risk are associated with characteristics of the loan such as borrower credit scores, loan-to-value ratio, back-end ratio, and availability of cash reserves.

C.2. Industry Efforts to Control Credit Risk: An Overview

Efforts designed to encourage first-time ownership among lower-income households involve credit risk that exceeds those of loans to higher-income households. The lower down the income scale one goes, the less discretionary income there is available for emergencies, and the greater the likelihood that there will be no insurance or other resources available to assist during those emergencies. These factors increase the likelihood and severity of extended delinquencies and foreclosures. The mortgage industry has adopted several ways of controlling for this risk on loans targeted to low-income borrowers and underserved areas:

- responsible underwriting changes that address special circumstances of low-income and inner-city borrowers;
- limiting the layering of multiple risk factors as in automated mortgage scoring and underwriting systems
- pre-purchase and post-purchase counseling; and
- proactive servicing.

Table 6.7

Product Guidelines

Program Name	Term (In Years)	LTV	CLTV*	Income	Front-end Ratio	Back-end Ratio	Credit	Reserves	Contributions	MI Coverage	Homebuyer Education
Industry Standard	30 or less	80%			NA	33	High Credit Scores (unlikely to allow less than 620)	Two months	20%	Required if down payment is less than 20%	Not Required
Industry Affordable	30 or less	Max 97%			NA	Greater than 38	Low or no Credit Scores	Waived or reduced	3%	Waived or reduced	Required
FHA 203(b)	15, 30	Max 97%	100% Maximum loan amounts by county	no income requirements	29	41	No minimum FICO. Basic credit guidelines	N/A (reserve required for 2,3 or 4 unit)	3% down payment that can come from flexible sources	Upfront premium of 1.5% and .5% per year in a monthly payment	Required
Fannie MyCommunity 100 Plus	30 or less	Max 100%	105%	100% AMI or high cost areas (up to 115% in non-metro counties). No income limit in Fannie Neighbors Areas	41% single qualifying ratio		Min 620 FICO (can be lower when borrower has experienced specific extenuating circumstances)	No min reserves (EEM 1 Month)	1% or $500, whichever is less	35% coverage	Required
Fannie 3/2	15, 30	Max 95%	105%	100% AMI or high cost areas	33	38	No minimum FICO. Basic credit guidelines		5% (3% from borrower's own funds, 2% from relative, govt agency, employer or non-	35% coverage	Required
Fannie Mae Community Home Buyer's Program		Max 95%	105%	100% AMI or high cost areas	33	38		None	5% from Borrower's funds		Required
Fannie 97	15, 30	Max 97%	105%		33	38		One month PITI	3% down payment that can come from flexible sources		Required
Freddie Mac Affordable Gold Alt 97	15, 20, 30	MAX 97%	105%; up to 100% if Affordable Seconds is from lender	100% AMI or high cost areas	NA	40	Min 680 FICO	One month PITI	3% from borrower's own funds, 2% from relative, govt	35% coverage	Required
Freddie Mac Affordable Gold 97	15, 20, 30	MAX 97%	105%; up to 100% if Affordable Seconds is from lender	100% of AMI with exception in certain high cost areas	NA	40	Loan Prospector "accept"	One month PITI	3% required from Borrower Funds or other equity (2% from other sources)	30% coverage	Required
Freddie Mac Affordable Gold 3/2	15, 20, 30	Max 95%	105%; up to 100% if Affordable Seconds is from lender	100% of AMI with exception in certain high cost areas	NA	40	Loan Prospector "accept"	One month PITI	3% required from Borrower Funds or other equity (2% unsecured loan from an agency)	30% coverage	Required
Freddie Mac Affordable Gold 5	15, 20, 30	Max 95%	105%; up to 100% if Affordable Seconds is from lender	100% of AMI with exception in certain high cost areas	NA	40	Loan Prospector "accept"	One month PITI	5% borrower's own funds (2% closing costs from relative, govt agency, employer or non-profit, property seller contributions up to 3%)	30% coverage	Required

Source: Center for Self-Help
*CLTV=Combined LTV

These are briefly discussed next, because they are important for understanding why recent affordability initiatives might not result in excessive increases in mortgage default rates. After that, information on the early default performance of affordable loans is summarized.

Prudent Underwriting Changes. The result of the Community Homebuyer experiment has been that mortgage insurers and the GSEs have modified underwriting standards in several ways that treat low-income households more fairly. The goal of these changes is not to loosen risk standards, but rather to identify creditworthiness by alternative means that more appropriately measure the circumstances of these households. One change that assists targeted households is the use of rent and utility payment history as a measure of creditworthiness, in place of a more traditional credit history based on repayment of debt. This assists those households who have stable finances but who have not previously utilized debt financing. To allow for cultural differences, pooling of funds among extended family members is now being allowed under certain circumstances. Other ways in which standards have been adjusted include allowing that part of the down payment beyond the first three percent to come from gifts, grants, or unsecured second loans, and adjusting appraisal standards to permit some mixed use in neighborhoods. These changes seek to broaden homeownership opportunities to previously underserved groups, particularly new immigrants and ethnic minorities without leading to undue credit risk.

Limits on Risk Layering. The term "risk layering" is used in the industry to refer to situations where too many borrower-qualification standards are relaxed simultaneously. An example would be a low down payment combined with a high debt-to-income ratio, a low level of cash reserves at closing, and a poor credit history record. As discussed later, some of the earlier special lending programs failed because they involved significant layering of risk. The industry has now developed tools such as mortgage scoring to control this layering of risk. Under these new techniques, the risk of default on a low-down-payment loans is reduced by requiring compensating factors such as a good credit record or a low debt-to-income ratio.

Automated Underwriting. Automated mortgage scoring was developed as a high-tech tool with the purpose of identifying credit risk in a more efficient manner. Evidence indicates that automated mortgage scoring is more accurate than manual underwriting in predicting borrower risks. Mortgage scorecards express the probability that an applicant will default as function of several underwriting variables such as the level of down payment, monthly-payment-to-income ratios, cash reserves, and various indicators of an applicant's creditworthiness or credit history. Mortgage scorecards are statistically estimated regression-type equations, based on historical relationships between mortgage foreclosures (or defaults) and the underwriting variables. The level of down payment and credit history indicators, such as a FICO score, are typically the most important predictors of default in mortgage scoring systems.

In addition to using automated underwriting systems as a tool to help determine whether a mortgage application should be approved, the GSEs' automated underwriting systems are being further adapted to facilitate risk-basked pricing. With risk-based pricing, mortgage lenders

can offer each borrower an individual rate based on his or her risk. The division between the subprime and the prime mortgage market will begin to fade with the rise of risk-based pricing, which is discussed in the next section on the subprime market.

Pre-purchase Counseling and Homebuyer Education. This is becoming a significant tool for increasing opportunities for underserved borrowers in the mortgage marketplace. Instead of restricting credit to certain groups with traditionally high default rates, lenders can allow households within those groups to self-select out on the basis of information provided in pre-purchase education courses. Households for whom ownership could be financially risky generally decide not to purchase after they have completed such a course. A survey performed by the University of Michigan on households having undergone a homebuyer education course showed that over 30 percent decided that ownership was not in their best interest.[32]

At the same time, counseling and education courses improve the creditworthiness of borrowers by teaching them how to better manage debt and home maintenance. In addition, when education is part of a community outreach program, it can expand the base of potential homebuyers. MGIC has reported that two-thirds of borrowers insured under its affordable housing initiatives could have qualified under traditional underwriting, but did not know that homeownership was within their reach until an outreach effort was made.[33]

A recent study by Hirad and Zorn (2002) measure the effect of home-buyer counseling on the performance of home mortgages. This study finds that borrowers who attend homebuyer education counseling better understand how to obtain and maintain a mortgage. Therefore, they are less likely to become delinquent or default. The study provides the first empirical evidence that borrowers who received prepurchase homeownership counseling were less likely to become sixty-day delinquent that similarly situated borrowers who did not receive prepurchase counseling. Classroom and individual counseling were shown to be effective approaches to mitigate default risk.[34]

Monitoring and Loss Mitigation. A key factor in mitigating losses is a strong pro-active servicing organization that performs credit counseling for delinquent borrowers.[35] Some in the

[32]By stressing the seriousness of homeowner responsibilities, the Michigan State Housing Development Authority caused a self-selection process which led to no loan defaults in the first three years of a statewide homeownership program that originated 4,500 loans.

[33]As quoted in England (1994, p. 51), one community housing group involved in promoting affordable housing expects that only 13 percent of households going through their prepurchase education will actually become homeowners, though they expect to increase this through extended one-on-one counseling.

[34]The study indicates that counseling administered through home study and over the telephone is not an effective approach to mitigate default risk.

[35]While most homeowners with loans in the conventional market are able to recover from 90-day delinquencies (3 missed payments and a fourth due), it is recognized that households who cannot generate savings for significant downpayments will also have difficulties generating the cash necessary to cure delinquencies that extend more than one or two months. Thus the proactive servicing stance provides early intervention.

industry even provide ongoing homeowner education after the initial home purchase. All major loan servicers now have loan workout departments, which specialize in foreclosure avoidance techniques. In addition, private mortgage insurers and the GSEs now offer training to loan servicers on default avoidance and loss mitigation. The GSEs have introduced automated models that can be used by servicers to predict the likelihood that a delinquent borrower will continue to miss payments and to determine whether that borrower requires more intensive loss mitigation efforts. Fannie Mae introduced its "Risk Profiler" to predict a borrower's payment behavior by incorporating credit-scoring techniques, credit data and property equity data.[36] Freddie Mac also introduced a statistically based delinquency management tool, known as "Early*Indicator*."[37] These risk-reduction factors may make it possible for the GSEs to buy special affordable loans without reducing their overall profitability.

Costs Associated with Risk Mitigation. Mitigation of risk on special affordable loans with high loan-to-value ratios involves labor-intensive counseling. Prepurchase counseling is generally performed by local Consumer Credit Counseling Services affiliates, who are funded by lenders, or other non-profit counseling agencies funded by HUD or state and local governments. Prepurchase education courses, which do not necessarily have one-on-one counseling, are paid for by loan originators. Post-purchase counseling to mitigate delinquencies and foreclosures is generally performed by loan servicers, though many do provide information on services provided by HUD-approved counseling agencies. Thus, special affordable loans could require higher servicing fees and potentially higher mortgage insurance premiums. While these charges would entail higher effective interest rates on loans to low-income households, they would not be so high as to cause affordability problems of their own.[38]

C.3. Termination Performance of Affordable Lending Programs

The Economic Analysis for the 2000 Rule reviewed the limited research and empirical data on the early default experience of the new affordable housing programs. Several of the studies reviewed concluded that special targeted lending was no more risky than traditional products available to low-income families and was profitable when done well.[39]

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[36]Fannie Mae. (1999), *Fannie Mae's 1998 Annual Housing Activities Report*. Submitted to the U.S. Department of Housing and Urban Development, (March 16, 1999), pp. 35-6.

[37] Freddie Mac. (1999), *Freddie Mac's 1998 Annual Housing Activities Report*. Submitted to the U.S. Department of Housing and Urban Development, (March 16, 1999), p. 48.

[38]GE Mortgage Insurance Corp. has gone so far as to use the additional insurance premiums charged on 3-percent-downpayment loans to pay for counseling agencies to contact borrowers when just one loan payment has been missed (the sixteenth day of a delinquency), in order to attempt to work out financial difficulties before the delinquency becomes an unrecoverable default.

[39]The studies reviewed in HUD's 2000 Economic Analysis investigated ways to mitigate the increased risk of affordable lending, along the same lines as discussed in Section C.2 above. At that time, and just as now, there was

Traditionally, evaluating the financial returns and risks of affordable lending programs has focused on whether they have differential default risk when compared with prime mortgages. More recently the debate has shifted to focus on whether affordable housing loans incur differential prepayment risk as well. A prepayment risk premium is a significant cost of home mortgage lending. Research examining prepayment risk finds that households that are less financially endowed or less financially sophisticated have lower than expected prepayment risk. This suggests that the increased cost of added default risk associated with affordable loans can partially be offset by a premium for lower prepayment risk for these loans. In other words, to examine the financial return on a low-income loan, one must consider both types of risk—credit (default) risk and prepayment risk.

HUD received several comments concerning the impact of affordable products on neighborhoods. Commenters cautioned that affordable products that are introduced into the market under favorable economic conditions may experience increasing defaults and foreclosures during periods of higher interest rate, higher unemployment and/or lower appreciation rates. One commenter indicated that 15 percent or more of borrowers in some affordable housing products could experience default in an economic downturn. Another commenter indicated that as defaults on affordable products rise, inner city neighborhoods are especially hard hit. A large number of foreclosures in an area may lead to abandon properties, serious blight, and disinvestments in the community.

HUD carefully reviewed the comments regarding mortgage default rates related to affordable products. The GSEs have successfully implemented affordable products by making marginal changes to one or more of their standard underwriting guidelines to offer a more flexible and affordable loans. Two examples include Fannie Mae's Community Home Buyers Program and its Community 100 pilot. The GSEs have also provided homebuyer education programs that better prepare borrowers for homeownership. Prepurchase counseling programs have lowered homebuyers' delinquency rates.[40] Since the implementation of the affordable housing goals, the GSEs increasing presence in these underserved markets has benefited the borrowers and the neighborhoods these products target. There is no evidence that the financial returns of the GSEs have suffered as they have enter low-income markets under the housing goals.

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only limited empirical research available on the recent affordable lending programs. An example of the studies reviewed in the 2000 Economic Analysis was the study by Michael Stamper, who indicated that one effective way to control the default risk associated with lending to low-income families was by limiting the layering of multiple risk factors. According to Stamper, AU systems like Loan Prospector mortgage scoring system can be used to weed out those borrowers with multiple risk factors who are more likely to default and to keep those borrowers who have compensatory factors (such as a good credit history) that suggest they would continue their mortgage payments during adverse times. See Michael K. Stamper, "Revisiting Targeted-Affordable Lending: Fresh Evidence Finds Lower Default Rates", *Secondary Mortgage Markets: A Freddie Mac Quarterly*, October 1997.

[40] Abdighani Hirad and Peter Zorn, "Prepaurchase Homeonwership Counseling: A Little Knowledge is a Good Thing", Low-Income Homeownership: Examining the Unexamined Goal editors Nicolas Restinas and Eric Belsky, pp. 146-174.

The following section reviews the recent literature investigating the default experience of affordable lending, as well as recent studies on the important role that prepayment experience plays in evaluating risk for low-income borrowers. Finally, it discusses the importance of modeling defaults and prepayments jointly in competing risks models.

a. Default Risk on Affordable Products

Freddie Mac Study. One mechanism that the GSEs are using to reach out to underserved populations is their automated underwriting (AU) systems. According to both GSEs, the credit risk associated with affordable lending can be controlled through use of these systems. Gates, Perry and Zorn (2002) use information from Freddie Mac's Loan Prospector Automated Underwriting service to provide information on questions raised about the impact of AU systems on underserved populations. These questions focus on the relative accuracy of automated underwriting compared with manual underwriting and also whether AU has increased the amount of mortgage credit to underserved borrowers.

The study finds that AU systems more accurately predict default risk in comparison to manual underwriters, and that this increase in accuracy results in higher borrower approval rates, especially for underserved populations. The evidence strongly supports the view that AU provides considerable benefits to consumers, mainly those at the margin of the underwriting decision.

To examine AU's accuracy[41] and impact on borrowers, the study used two versions (1995 and 2000) of Loan Prospector to analyze three groups of mortgage loans purchased by Freddie Mac. The groups included: (1) purchases of 1994 and 1995 originations of conventional, conforming mortgages secured by one-unit properties; (2) purchases of 1993 and 1994 originations under affordable housing programs; and (3) all applications processed by Loan Prospector from 1995 to 2000.

According to the study, the first group of loans indicated that Loan Prospector is highly accurate. Loans rated as "caution" by Loan Prospector 2000 were four times more likely to default than the average for all loans. Loan Prospector was also accurate at predicting risk for low-income and minority borrowers. Low-income borrowers who received a caution flag experienced default at four times the average, and minority borrowers who received a caution flag experienced default at five times the average.

The study also found that Loan Prospector is more accurate than manual underwriting, after analyzing the second group of loans generated through affordable housing programs. Manual underwriters rated 51.6 percent of these loans as accept, while automated mortgage

[41] An AU system is accurate if the loans it predicts to be low-risk perform better than loans it predicted to be high-risk.

scoring would have rated 87.1 percent of these loans as accept. In addition, the study found that Loan Prospector was more accurate than manual underwriting when predicting risk even with a higher approval rate, and that the 2000 version of Loan Prospector was more accurate than the 1995 version.

The authors state that increased accuracy in automated underwriting will likely drive the mortgage market to risk-based pricing because improved accuracy and competition will do away with the cross-subsidization inherent to average-cost pricing. The study concludes that underserved borrowers are still less likely to be approved for a loan, even with the current development in mortgage lending. This difference in approval rates can be attributed to societal inequities in financial capacity and credit, which are key components in both automated and manual underwriting.

Fed CRA Study. In November 1999, Congress directed the Board of Governors of the Federal Reserve System to conduct a comprehensive study that focused (1) on the delinquency and default rates of loans made in conformity with the CRA and (2) on the profitability of such lending.[42] The Fed report relies upon survey methodology sampling the largest 500 financial institutions subject to CRA requirements. The institutions responding to the survey are estimated to account for roughly 40 to 55 percent of CRA-related lending in each loan product category. The survey provides both qualitative and quantitative information.

The Fed report indicates that CRA loans are on average profitable, although slightly less profitable than standard loans. The level of profitability varies by loan type. The following table provides estimates of the percent of CRA-related dollars lent that were profitable broken down by CRA loan category.

[42]Board of Governors of the Federal Reserve System, *The Performance and Profitability of CRA-Related Lending,* July 17, 2000. *http://www.bog.frb.fed.us/boarddocs/surveys/craloansurvey/*

	(by % of CRA loans)		
Type of CRA loan	**Marginally Profitable**	**Profitable**	**Total %**
Home Purchase and Refinance	20%	65%	85%
Home Improvement	30%	49%	79%
Small Business	5%	95%	100%
Community Development	33%	66%	99%
Special	32%	29%	61%

The survey also collected data on loan performance. The results are mixed. Home purchase and refinance CRA loans perform less well than other home purchase and refinance loans—46 percent of the dollars associated with CRA-related loans were originated by institutions that report that credit losses are higher for CRA-related home purchase and refinance loans than for other home purchase and refinance loans. When assessed on a per CRA dollar basis CRA-related home purchase and refinance loans appear to have higher origination and servicing costs, but similar pricing, when compared with other home purchase and refinance loans.

The results for home improvement lending are somewhat better. The majority of respondents (on a per institution basis) report that the performance of CRA-related when compared with overall or other home improvement lending is about the same. On a per CRA dollar basis, credit losses are somewhat higher than for other loans. On both a per institution and per CRA dollar basis, the majority of respondents in all asset-size categories report that origination and servicing costs, credit losses, and prices associated with CRA-related and other home improvement lending are about the same.[43]

Special lending programs are programs specifically developed by lenders in order to enhance CRA performance. Obtaining either a satisfactory or outstanding CRA rating is a reason mentioned for about 75 percent of the programs. About 75 percent of the programs involve activities by third parties. On a per program basis, respondents report that a majority of the CRA special lending programs have low delinquency and charge-off rates.

Other Studies. Listokin and Wyly conducted case studies of financial institutions, homebuyers, and communities in their analysis of the transformation of housing and mortgage markets in recent years.[44] They find (p. 600) that "there has been no definitive research to

[43]No comparison group was available for CRA-based community development lending. As with all other types of lending, larger institutions reported poorer performance than smaller institutions. The results for small business lending indicate that CRA lending performs equally with overall small business lending. Banking institutions in each asset size category report roughly the same delinquency and charge-off rates for CRA-related and overall small business lending; there are also few reported differences for origination and account maintenance and monitoring costs, credit losses, and pricing.

[44]David Listokin and Elvin K. Wyly, "Making New Mortgage Markets: Case Studies of Institutions, Home Buyers, and Communities," *Housing Policy Debate*, Volume 11, Issue 3, 2000, pp. 575-644.

suggest that efforts to reach underserved markets are, on balance, riskier or less profitable than lending to higher-income borrowers." However, they conclude that based on their interviews, there is a "broad and growing consensus on the profitability of prudent efforts to reach underserved markets."

According to National Mortgage News, a recent study by the National Community Capital Association concluded that contrary to popular belief, investing in economically disadvantaged communities and lending to low-income people is as safe as, or safer than, loans to wealthier individuals and communities.[45] This study of the performance of over 100 community development financial institutions (CDFIs) in 2002 found that the net chargeoff rate for community development financial institutions was 0.70 percent in 2002, compared with 0.97 percent for all commercial banks.

b. The Role of Prepayment Risk

Several recent studies have taken a new approach to looking at the financial return of lending to low-income borrowers. They point out that while default cost of affordable loans may be higher than other mortgages, this may be offset by the savings associated with slower than expected prepayment rates for affordable loans. This section discusses the impact of prepayment experience on evaluating risk for affordable loans.

Van Order and Zorn (2002) examine the prepayment option in two ways: first, when the option is "in the money," or when mortgage rates have fallen;[46] and second, when the option is not in the money. Before controlling for loan characteristics, low-income and minority borrowers are slower to prepay than other borrowers when the option is in the money, but are about the same for out of the money prepayments. Adjusting for loan characteristics such as credit history, loan-to-value ratio, and loan amount, low-income and minority loans are slow both in and out of the money.

Overall, blacks and Hispanics prepay significantly more slowly than whites and other minorities, and low-income borrowers prepay more slowly than high-income borrowers. Much of the difference in the likelihood of refinancing is due to credit history and LTV. Prepayment rates among minorities are partially explained by the racial composition of the neighborhood and partially by the race of the borrower. There is almost no effect of individual income, but a small effect of neighborhood income on prepayment. Income effects on prepayment fell over time, and nearly disappeared after adding controls. The effects of race on prepayment have not changed over time for black and Hispanic borrowers.

Competing Risk Models. While the analyses discussed to this point model default or prepayment probability without consideration of other conditional termination risks, more recent

[45] Study by the National Community Capital Association, as cited in *National Mortgage News*, February 25, 2004.

[46] A mortgage call option is "in the money" when savings from refinancing a mortgage outweigh any transaction costs.

research indicates that default and prepayment behavior are competing risks, and hence should be jointly modeled (Deng, 2000, Deng, Quigley, and Van Order 2000). An option-based hazard model is used to simultaneously estimate borrowers' default and prepayment decision such that a mortgage loan may be viewed as a fixed income instrument combined with American put and call options held by the borrower and written by the lender.

Borrowers have an incentive to exercise a mortgage put option when the house is worth less than the outstanding mortgage or trigger events occur such as a loss in income or job that make it impossible for the household to meet its financial obligations. In these cases, the borrower can save financial resources by defaulting.[47] A borrower has an incentive exercise a call option (by prepaying or refinancing an existing mortgage) when market interest rates are less than his or her mortgage rate, after taking transactions costs into account.

Two studies based on competing risk estimate the probability of default and prepayment for different types of affordable loans. The main finding is that certain borrower characteristics that have a strong association with one option may have the opposite association with the other option. For example, a lower-income borrower with a poor credit history may have higher default risks but lower refinancing risks due to credit problems and/or liquidity constraints that typically affect the ability to qualify for a new loan (and thus limits that borrower's ability to refinance). This has important implications for affordable lending. This finding is consistent with earlier research that found prepayments were dampened by income and collateral constraints (Archer, Ling, and McGill, 1996; LaCour-Little, 1999).

The first study, by Deng and Gabriel (2001), uses FHA loans originated during 1992-1996 to examine the difference in loan performance across borrower and loan characteristics. The study finds that the higher default probabilities of high-credit-risk groups are offset by the dampened prepayment propensities resulting in lower loan termination propensities. The estimated 5-year cumulative probability of mortgage termination among high-default-risk borrowers is 37 percent, well below the 60 percent for low-default-risk borrowers. LTV ratio is found to be negatively associated with prepayment risk and positively associated with default risk. Exercise of the prepayment option is significantly damped among first-time borrowers, single-female borrowers, and borrowers with higher value properties while younger and higher income borrowers are more likely to prepay. Lower-income and higher credit risk borrowers are higher default risk borrowers.

The second study, by Dunsky et al. (2001), examines the termination behavior for GSE housing goal and non-goal loans and conclude these two types of loans perform differently. Housing goal loans have higher average default rates and lower average prepayment rates, but at the same time are in some ways a more stable investment, being less responsive to declines in house values or interest rates. Furthermore the authors state that the probability of default by borrowers who meet the GSE affordable housing goals is not nearly as sensitive to whether the

[47]However, borrowers who have positive equity in a house and experience a trigger event can alternatively sell the property instead of defaulting.

home is worth less than the mortgage, as originally thought.

These results are based on a GSE loan-level performance data consisting of over 150,000 loans originated in 1995 and tracked through 1999. It includes only fixed rate, fully amortizing loans secured by owner occupied single-family detached properties from metropolitan areas. In addition to performance, the model includes the number of affordable housing goals satisfied by the loan, if any, the borrower's credit score at origination, the probability that the loan is in a negative equity position at each month (PNEQ), and the present discounted costs of the loan. A number of local economic indicators are also controlled for, including unemployment rate, divorce rate, per capita income, and housing units authorized.

A multinomial logistic regression model is used to jointly estimate the conditional prepayment and default probabilities. Estimated coefficients are then used in a sensitivity analysis that simulates the conditional default and prepayment rates for every combination of time (0-60 months) and probability of negative equity (0—30 percent). At 24 months, the conditional default rate for non-goal loans is 0.02%, for one-goal loans 0.03%, two-goal loans 0.05%, and 3-goal loans 0.10%. The simulation predicts a conditional default rate peak at 20 months for both non-goal loans and loans which meet all three goals, and for all levels of PNEQ. Furthermore, increases in probability of negative equity increase the conditional default rate in all months. However, non-goal loans are more sensitive to negative equity than are any of the goal loans, with three-goal loans being the least sensitive. Loans that qualify for more goals are less likely to prepay, perhaps because they have less access to credit for refinancing.

C.4. Subprime Lending

The subprime segment of the mortgage market is of increasing importance to the GSEs (see Section F.7 of Chapter IV). The subprime mortgage market provides financing for many low-income and minority borrowers whose risk profiles differ markedly from borrowers who qualify for prime mortgage products. Millions of Americans with less than perfect credit or that cannot meet some of the tougher underwriting requirements of the prime market for reasons such as inadequate income documentation, limited down payment or cash reserves, or the desire to take more cash out in a refinancing than conventional loans allow, rely on subprime lenders for access to the mortgage market.

This section provides an overview of the different risk classes that make up the subprime market and reviews the limited literature on evaluating the default risk for these loans. In 2003, $202.9 billion in securities backed by subprime mortgages were issued. This is a 50.8 percent increase from 2002 issuance of $134.5 billion.[48] Among the top 20 subprime issuers, 49.1 percent of their total MBS production went to the GSEs, up from 34.4 percent in 2002.[49]

[48] Inside B&C Lending, January 12, 2004, p. 1.

[49] Inside B&C Lending, January 26, 2004, p. 1.

The GSEs involvement in the subprime market has benefited two types of borrowers: "A" risk and "near A" risk. The first group consists of borrowers with risk profiles similar to "A" borrowers, but receive mortgages from a subprime lender. The GSEs' outreach and education efforts increase the likelihood that "A" borrowers will use cheaper prime lenders for refinance mortgages, and reduce their reliance on subprime firms. The second group, borrowers who are near A credit risks, have growing access to mortgage products offered by the GSEs as these borrowers are increasingly served by GSE seller/servicers. The GSEs involvement in the subprime market is reviewed in Section F.7 of Chapter IV. This remainder of this section briefly discusses issues related to the financial risks of subprime loans.

Calem, Gillen, and Wachter (2002), using HMDA data from Philadelphia and Chicago, found that the share of loans within a tract that are subprime is strongly associated with several neighborhood risk indicators and with the proportion of homeowners that are African-American. In a separate, borrower-level logit analysis of the probability of a loan being subprime, they find that the neighborhood risk factors (such as low credit scores of residents) are still significant, together with simply being an African-American borrower.[50]

The subprime market is divided into different risk categories, ranging from least risky to most risky: A-minus, B, C, and D. While there are no clear industry standards for defining the subprime risk categories, Inside Mortgage Finance defines them in terms of FICO scores—580-620 for A-minus, 560-580 for B, 540-560 for C, and less than 540 for D. Recent estimates of default rates for a 30-year Fixed Rate Mortgage were 8.85 percent for A-minus (with an 85 percent LTV), 9.10 percent for B credit (with an 80 percent LTV), and 10.35 percent for C credit (with a 75 percent LTV).[51] As the low loan-to-value (LTV) ratios indicate, one loss mitigation technique used by subprime lenders is a high down payment requirement. Because of their higher risk of default, subprime loans typically carry much higher mortgage rates than prime mortgages.

However, Courchane, Surette, Zorn (2002) find credit risk indicators do not appear to

[50]In addition to the usual HMDA indicators (the percent of conventional applications denied, percent FHA, percent African-American, log average loan amount, log average income, etc), this study constructs several neighborhood and borrower-level risk indicators using census or proprietary data. Indicators which were significant in all models included: the percent of owners who were black, the percent of borrowers who were female, and the percent of residents with low credit scores or no credit records (drawn from Experian). Indicators that were significant in some but not all specifications included: the log average loan amount; the turnover in owner-occupied homes (HMDA sales over 1990 census data); and the rental capitalization rate (median rent over median value). Percent of conventional applications denied was significant in all tract-level models but in the logistic regression only for Chicago. The percent college graduates is significant in the borrower-level logits but not generally at the neighborhood level. Log median income and foreclosure rate (from Sheriff's sales) were not generally significant. Paul S. Calem, Kevin Gillen, and Susan Wachter, "The Neighborhood Distribution of Subprime Lending," Preliminary Draft, September 2002

[51]*Inside B&C Lending,* published by Inside Mortgage Finance, February 17, 2003, page 13.

fully explain why some borrowers end up with subprime loans. Rather, search behavior and demographic characteristics appear to help explain market channel, which is strongly associated with borrowers perception of positive loan outcomes. This study finds subprime borrowers are more likely to be minority, low-income and older, and to lack knowledge about the mortgage process. These borrowers are also more likely to have poor self-assessed credit, less likely to have a financial "safety net" and more likely to have suffered a major adversity, such as illness or unemployment. However, in a multivariate analysis such credit risks were not able to explain all of the increased likelihood of obtaining a subprime loan. A model that adds knowledge, search behavior and demographics predicts receipt of a subprime loan significantly better than the credit-risk model alone. The most significant of these additional factors was whether the borrower searched less for the best rates and terms.[52]

Using a competing risk analysis of default and prepayment risks for prime and non-prime loans over a three year period, Pennington-Cross (2002) found that non-prime loans (defined by interest rate rather than lender or borrower characteristics) prepay and default more often than prime loans, and respond in the same direction to economic stimuli (house prices, interest rates, and unemployment rates) and borrower characteristics (credit scores and down payments).[53] However, the effects of these influences on prime and nonprime loans vary in strength. For example, when interest rates drop substantially, prime loans prepay (refinance) at a higher rate than non-prime loans. In addition, because prepayments are much more common than defaults for both prime (344 times more likely) and non-prime loans (37 times more likely), termination rates (defaults plus prepayments) are dominated by prepayments. This leads to the counter-intuitive finding that termination rates decline as economic conditions worsen because decreases in prepayments swamp increases in defaults. It is important to note that while the non-prime loans in this study are found to have similar default experience to affordable loans, these non-prime loans have higher prepayment rates than affordable loans. This would imply that non-prime loans have different characteristics than affordable loans i.e., non-prime loans prepay faster than affordable loans.

The GSEs have been prudent in their pursue of subprime lending, focusing on the top part of the market, the "A-minus" and "Alt A" segments.[54] The GSEs subprime products are integrated into their automated underwriting systems and are approved based on mortgage

[52] In a third model incorporating the channel—prime or subprime—of any previous loan, borrowers with existing subprime loans were more likely to receive subprime refinancing, even controlling for all other factors. Finally, in an analysis of borrower's satisfaction with their loans, market channel—prime or subprime—explained fully half of the difference in satisfaction between prime and subprime borrowers, even controlling for risk factors, knowledge and search behavior and demographics.

[53] Pennington-Cross, Anthony. *Credit History and the Performance of Prime and Non-Prime Mortgages.* OFHEO, September 13, 2002.

[54] A-minus mortgages are typically those where borrowers have less than perfect credit. Alt A mortgages are originated to borrowers who cannot document all of the underwriting information in the application but generally have FICO scores similar to those in the prime market.

scoring models. These models have proven over the years to be an effective tool in limiting risk layering. The GSEs charge lenders higher fees for making these loans. As a result these higher risk loans are priced above those offered to prime borrowers but below what subprime lenders would otherwise charge for these loans. Setting prices for making loans with different risk is a form of risk-based pricing. This is an important change in the way the GSEs have traditionally operated their prime loan business where all prime loans are offered "average loan pricing".[55]

D. GSE Purchases Under the New Housing Goals

The next section develops a financial model of the credit costs of different types of GSE loan purchases (single-family, multifamily) that is used to assess the likely effects of the housing goals on GSE profits and financial condition. Required loan purchases are simulated under various criteria and their profitability estimated. The main conclusion is that although the housing goals will require increases in GSE purchases of goals-related loans and, though they may not be as profitable as other GSE business, they will produce reasonable financial returns and are not likely to have impacts on the financial safety and soundness of the GSEs. Before discussing the profitability analysis, this section presents a model the projects the additional purchases that would be required to meet the new housing goals.

The purchase scenarios from this model, while purely illustrative, help to provide a sense of the overall magnitudes involved in reaching the goals. The purchase scenarios pertain to the 2005-2008 period in which the new housing goals will be in effect. While the model is explained in this section, examples of purchase scenarios produced by the model are presented and discussed in Chapter III.

D.1. Projected Goals Performance and Additional GSE Purchases Needed to Meet the Housing Goals

This section, along with Sections C-E of Chapter III, examine the anticipated impacts of the housing goals on the GSEs' purchases. The purchase simulation model, which is explained in this section, does this by (1) projecting the GSEs' performance if the goals were not changed (called the baseline projection); (2) calculating the magnitude of any shortfalls from the new goals; and (3) specifying scenarios for how the additional goals business is distributed across property types. There are, of course, many ways in which the GSEs can target purchases to meet the goals. Scenarios developed are based on several assumptions and are purely illustrative. However, HUD has attempted to make the projections as realistic as possible. The estimates are useful for three reasons. First, the baseline projections of each GSE's performance indicates the extent to which that GSE falls short of the new goal and subgoal targets. Second, they provide an estimate of the magnitude of additional goals-qualifying mortgages that the GSEs must

[55]Average cost pricing for prime mortgage borrowers is the standard practice by prime lenders of offering borrowers approved for a prime mortgage the same interest rate regardless of the risk of loss to the lender.

purchase to meet HUD's housing goals. Third, as discussed in the next section, the scenarios provide benchmarks for judging the potential credit costs to the GSEs under different economic conditions and levels of default risk.

The analysis starts with a baseline, that is, assumptions about what the GSEs would buy in absence of the new goals. Separate versions of the purchase model can assume that the GSEs' performance is similar to their performance in 2000, 2001, 2002, and 2003, and to their average performance, for example, between 2000 and 2002. For instance, consider the purchase model based on 2002-2003 performance. By "performance in 2002-2003" or "2002-2003 parameters" we mean the *average* share of a GSE's single-family-owner loans accounted for by low- and moderate-income loans, loans in underserved areas, and special affordable loans during the period, 2002 and 2003.[56, 57] As discussed below, sensitivity analysis can be conducted based on varying each GSE's 2000-2003 performance. The "individual performance" years (2000, 2001, 2002, and 2003) are interpreted similarly. For example, by "performance in 2002" or "2002 parameters" we mean the share of a GSE's single-family-owner loans accounted for by low- and moderate-income loans, loans in underserved areas, and special affordable loans during 2002.[58] As explained in Chapter III, which implements the purchase model, the "2002 or 2003 parameters" from a heavy refinance environment can be adjusted to make them realistic for a home purchase environment.

A second dimension of performance is the extent to which purchases satisfy more than one of the goals (that is, the degree to which purchased underserved loans have borrowers who are very-low income or low- and moderate-income, and vice versa). For example in 2002, 55 percent of Fannie Mae's single-family-owner special affordable units also satisfied the Underserved Areas Goal. Conversely, 26 percent of Fannie Mae's underserved area loans were also special affordable. The comparable percentages for Freddie Mac were 54 and 25 percent, respectively. The goals overlap issue must be considered in measuring the impact of higher goals because without such consideration, the impact of any given set of goals will be overstated, and conversely the determination of what is feasible will be biased downward.

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[56]For instance, the *unweighted* average low-mod share of Fannie Mae's purchases of single-family-owner home purchase loans for the years 2002 and 2003 was 45.6 percent compared to 43.2 percent for Freddie Mac (see Table 3.3a in Chapter III).

[57]The projected performance relative to the final goals differs from actual performance because of a differing refinance rate. Using "2002" as an example, 43.6 percent of Fannie Mae's single-family-owner home purchase loans went to low-mod borrowers compared to 39.0 percent of their refinance loans. In 2002, 70.7 percent of Fannie Mae's single-family-owner loans were refinance loans, resulting in an overall low-mod percentage of 40.3 percent for Fannie Mae. In the basic projection model, the refinance rate for Fannie Mae single-family-owner loans is predicted to be 40 percent, which leads to an overall low-mod percentage of 41.8 percent for single-family loans if Fannie Mae's purchase and refinance low-mod performance is assumed to follow the 2002 pattern.

[58]The goals-qualifying shares for single-family rental and multifamily mortgages are not as dependent on economic and affordability conditions as the goals-qualifying shares for single-family-owner mortgages. Therefore, they can be set independently of the goals-qualifying shares of single-family-owner loans.

Chapter 3's analysis based on the model focuses on the final housing goals and the home purchase subgoals for the years 2005-2008. The additional purchases under alternative goals (both higher and lower than the final ones) are also examined using the model.

Overview of Simulation Model. The basic issue concerns the magnitude of the additional goals-related loans that the GSEs must purchase in order to satisfy the new goals. To calculate the necessary additional purchases, HUD first estimates a baseline to determine the GSEs' goal performance in the absence of new goals. HUD does this by assuming that the GSEs will perform as they did in a particular year or set of years, as described above. HUD's model for projecting each GSE's baseline goals performance requires several additional assumptions, as discussed next.

The GSEs' goals performance must be estimated in the context of assumptions about the overall mortgage market. As explained in Appendix D of the Final Rule, an important parameter in determining the goals-qualifying share (e.g., the low-mod share) of the conventional conforming market is the "multifamily mix", which is the share of all (both single-family and multifamily) newly-mortgaged dwelling units accounted for by multifamily properties. Because multifamily units qualify for the housing goals at a much higher rate than do single-family units, the higher the multifamily mix, the higher the goals-qualifying shares of the market. For example, over 90 percent of multifamily units qualify for the low-mod goal, compared with about 40-45 percent of single-family-owner units. HUD's market analysis in the Final Rule focused on a multifamily mix of 15.0 percent, although a range of multifamily mixes were analyzed

For the same reasons as noted above, a higher assumed multifamily mix for a GSE's baseline business yields higher baseline projections of that GSE's goals performance (and thus a smaller shortfall from the new housing goals and less need to purchase additional goals-qualifying mortgages). In the analyses reported in Chapter 3, Fannie Mae's baseline multifamily mix is 12.0 percent, which is above its 1999-2002 average mix of 9.3 percent but below its 2000 level of 12.6 percent. Freddie Mac's baseline multifamily mix is 10.0 percent, which is 1.6 percentage points above its 1999-2002 average mix of 8.4 percent. Taking into consideration that (i) 2001 and 2002 were relatively high single-family refinance years, which lowered the multifamily share of both GSEs relative to what it would have been in a more typical year, and that (ii) Freddie Mac has been substantially increasing its multifamily purchases recently, the higher multifamily mix (compared with its 1999-2002 average) for Freddie Mac during the projection period appears reasonable.

Given an assumed multifamily mix (defined in terms of dwelling units) for the mortgage market, the dollar volume of multifamily originations depends on the average multifamily loan amount per unit (assumed to be $37,275) and the projected size of the single-family market. Appendix D of the Final Rule starts with a projection of $1,700 billion in total single-family 1-4 unit loans, which translates into $1,197 billion in conventional conforming loans. With a multifamily mix of 15.0 percent, this translates into $59.3 billion in multifamily originations. A higher projection of $1,900 billion for the total single-family market would yield projections of

$1,338 billion for the single-family conventional conforming market and of $66.3 billion for the multifamily market assuming a mix of 15.0 percent.

The GSEs are projected to have a combined 60 percent share of the single-family conventional conforming mortgage market—34.8 percent for Fannie Mae and 25.2 percent for Freddie Mac.[59] A conventional conforming market of $1,197 billion ($1,338 billion) results in $422 billion ($472 billion) for Fannie Mae and $296 billion ($330 billion) for Freddie Mac.[60]

For all scenarios, the distribution of single-family purchases between owner and rental mortgages is the average for the years 2000 to 2002. Any shift toward single-family rental purchases would increase projected goals performance for the same reason an increase in the multifamily mix increases goals performance (i.e., over 90 percent of single-family rental units qualify for the low-mod goal).

The GSEs' performance during recent years (2000-2003) is used for calculating the goal-qualifying shares of the various property types (single-family owner, single-family rental, and multifamily). The analysis can include variations on 2000-2003 performance for single-family-owners—for example, scenarios can be examined assuming the goal-qualifying parameters for a particular year (such as 2002). In addition, the single-family-owner parameters can be reduced or increased by a factor (such as 0.95 or 0.98 or 1.025).[61] In the case of a 0.95 factor, the reduction would produce a baseline projection that would include a smaller number of goal-qualifying

[59]The GSEs' share of the conventional conforming market (expressed in dollar terms) has been: 58 percent in 1998, 62 percent in 1999, 53 percent in 2000, 64 percent in 2001, and 69 percent in 2002. The 34.8 percent-25.2 percent split between Fannie Mae and Freddie Mac assumes that Fannie Mae makes up 58 percent of the GSE market. Fannie Mae's shares of the GSE market have been as follows: 57.4 percent in 1999, 57.2 percent in 2000, 58.8 percent in 2001, and 61.9 percent in 2002.

[60]With this single-family information, many of the aforementioned calculations can now be illustrated. The single-family conforming market of $1,197 billion translates into 9,037,323 single-family units; assuming a 15.0 percent multifamily mix yields 1,594,821 multifamily units, or a total of 10,632,144 newly-mortgaged single-family and multifamily units. Applying an average per unit multifamily loan amount of $37,175 to the 1,594,821 multifamily units produces dollar-based market estimate of $59.3 billion. Applying Fannie Mae's share of the single family market (34.8 percent) yields $422 billion in single-family purchases, or 3,335,794 single-family units financed. To obtained Fannie Mae's multifamily units, the number of single-family units is multiplied by (.12/(1-.12) since multifamily units are projected to be 12 percent of all units, resulting in a projected volume of multifamily units of 454,881. Combining 3,335,794 single-family and 454,881 multifamily units yields 3,790,675—the total number of dwelling units Fannie Mae is projected to finance in the baseline year. The calculations for Freddie Mac parallel these calculations for Fannie Mae—the only differences are that Freddie Mac's dollar-based shares of the single-family market is 25.2 percent and the share of its business that is multifamily is 10.0 percent. As explained in Appendix D of the Final Rule, the dollar magnitudes (e.g., single-family originations, multifamily dollars per unit) are not the important concepts on the projection model; rather, it is the share concepts (such as the multifamily mix percentage) that determine both the market's and the GSE's projected performance on the housing goals.

[61]For example, if the percentage of a GSE's single-family home purchase loans that qualified for the special affordable goal was 10 percent in 2002, the "95 percent (0.950) of 2002" scenario would use a special affordable percentage of 9.5 percent, instead of 10.0 percent.

loans, which would lead to a larger number of additional goal-qualifying loans that the GSE would need in order to meet the higher housing goals. Such a scenario could be used to represent a less affordable mortgage environment than has existed recently.

Baseline Performance. Section C.4.e of Chapter III provides examples of the baseline performance (on the goals and subgoals) projected by the model for each GSE under a variety of assumptions. In one of the simulations of a home purchase environment based on 2002-2003 parameters and a 10-percent multifamily mix for Freddie Mac, the baseline goals performance for Freddie Mac was as follows: 21.0 percent for special affordable, 51.4 percent for the low-mod goal, and 34.9 percent for the underserved areas goal—this was called "scenario A" in Chapter III. In another simulation that also assumed a 10-percent multifamily mix for Freddie Mac but also assumed slightly higher single-family-owner goal-qualifying percentages for Freddie Mac, the baseline goals performance for Freddie Mac was as follows: 21.4 percent for special affordable, 52.2 percent for the low-mod goal, and 36.0 percent for the underserved areas goal—called "scenario B" in Chapter III. Subtracting the goal targets from Freddie Mac's baseline goals performance yields the shortfalls in performance. Under scenario A, Freddie Mac's shortfalls for the 2005 goals are as follows: special affordable (1.0 percent), low-mod (0.6 percent), and underserved areas (2.1 percent). (See Table 3.11a in Chapter III.) The next step is to derive an illustrative scenario of mortgage purchases that would allow Freddie Mac to reach the goal levels for 2005.

Steps in Meeting Goals Shortfalls. The model follows the following steps in projecting mortgage purchases that will meet a particular shortfall, such as that given above for Freddie Mac.

1. The simulation model first calculates the number of special affordable multifamily units required to meet the special affordable multifamily dollar goal requirement, as well as the number of metropolitan single-family owner home purchase units needed to meet the metropolitan home purchase goal. Any additional shortfall on the overall special affordable goal is allocated across single-family units based on the GSEs' historical distribution of special affordable units across the single-family property types (including metropolitan home purchase).

2. All special affordable purchases also apply to the low-mod goal. The number of units needed to meet the low-mod metropolitan single-family owner home purchase goal is then determined. Any remaining shortfall of low-mod units is distributed across property types based on the projected baseline purchase patterns of low-mod units, which derives from the projections about the overall size of the single-family and multifamily markets.

3. Any additional low-mod purchases increase the total business (i.e. the denominator of the goals calculation), requiring a second calculation of the special affordable shortfall. This second shortfall is met by designating the appropriate number of low-mod purchases as special affordable.

4. A portion of the special affordable and low-mod targeted purchases also satisfy the underserved areas goal, based on historical cross-correlations. The number of units needed to meet the underserved metropolitan single-family owner home purchase goal is then determined. Any remaining shortfall in underserved area units is calculated after accounting for these byproduct underserved area purchases. As with the low-mod goal, targeted underserved area purchases are allocated across property types based on the projected baseline pattern of such purchases. Underserved area purchases that are also low-mod or special affordable, based on historical cross-correlations are added to those goal purchases. Note that it is possible for underserved area loans purchased as a byproduct of meeting the low-mod and special affordable goals to result in a performance that surpasses the underserved area goal. Conversely, targeted underserved area purchases may, as a byproduct, cause the special affordable or low-mod goals to be surpassed.

5. Finally, the need for additional low-mod purchases is evaluated a second time and the need for additional special affordable purchases is evaluated a third time, given that the purchase of additional targeted underserved area purchases also increases the denominator (i.e., total units). Any needed purchases are designated from among the underserved area purchases and are allocated across property types based on historical patterns.

At this point, readers are referred to Sections C.4e-f of Chapter III for examples of the additional purchases needed to meet shortfalls in goals performance. As emphasized in Chapter III, the additional purchase numbers produced by the model are purely illustrative, as a GSE could choose entirely different strategies to meet the final goals. However, they provide some sense of the magnitude of the additional effort required by a GSE that is short of the goals.

E. Results of 2004 Profitability Analysis

This section briefly summarizes the content of the 2004 profitability analysis and discusses the results. The results for baseline and targeted goals-qualifying purchases are compared and discussed in terms of their potential implications for the impact of the housing goals on GSE profitability. Appendix A outlines the methodology, models, and parameters used to analyze the GSEs' profits under the increased goals.

Response to Freddie Mac's Comment. Freddie Mac, in its comments, raised four concerns related to the Profitability Analysis. It claimed the Department used a flawed default framework, conducted a faulty analysis of the impact on return on equity, incorrectly analyzed the prepayment propensities of the GSE's retained portfolios, and assumed unreasonably high guarantee fees for goal-qualifying purchases. Each claim and HUD's response are provided.

No flaws in default framework. Freddie Mac raised two concerns: that the Department

failed to appropriately distinguish the differences in default behavior between goal-qualifying and non-goal qualifying loans and that the OFHEO default models used by the Department to reach its conclusions were inappropriate since they were calibrated to match behavior in stressful economic environments. These claims are simply incorrect.

First, the default framework assumes different default experience for goal and non-goal qualifying loans. The analysis includes additional scenarios that assumed proportionally higher default and loss rates on goal qualifying loans. For example, conditional default rates for low-income and/or geographically targeted loans are multiplied by 1.5. The adjustments are cumulative, so if a loan is both low-income and geographically targeted both adjustment factors are applied and the conditional default rate is increased by a multiple of 2.25 (1.5 times 1.5). Loss rates are increased by multiplying REO proceeds by 0.8 if the loan is classified as low-income and/or geographically targeted. These adjustments are also cumulative, so if the loan is both low-income and geographically targeted REO proceeds are multiplied by 0.64

Second, the default models reported by OFHEO were estimated on a large sample of GSE loans across a range of economic environments. OFHEO subsequently determined the values of adjustment constants, which when added to the model, would enable them to replicate the outcomes from a particular time period with severe economic stress. The default framework used here did not apply these calibration adjustments. Freddie Mac incorrectly assumes that these calibrations are applied in this model while they were not.

Impact on ROE is accurate. Freddie Mac questions several aspects of the financial analysis undertaken to assess the potential impact of additional affordable loan purchases on GSE profitability. The application of OAS analysis and calculation of expected ROE values is primarily a means of summarizing the underlying economic performance of GSE loans under alternative economic assumptions and purchase scenarios for GSE compliance with HUD's final affordable lending goals. With regard to the relative financial performance of these assets, similar conclusions would have been reached under almost any initial value for the required capital on GSE credit guarantees. What the analysis demonstrates is that assuming 45 basis points as an initial equity value or "buy-in" for engaging in this activity results in projected ROE values that are generally consistent with the overall ROE values reported by the enterprises in their annual financial statements.

Freddie Mac questions whether 45 basis points is the correct risk-based capital (RBC) level at which to set the implicit price at which a GSE is willing to extend credit guarantees, and claims that the required capital level is higher. Freddie Mac's comments do not specify what they mean by the required or true risk-based capital level, although we assume that they have in mind something like their own internal capital calculations or those of their financial safety and soundness regulator OFHEO. While the financial analysis applies more and less stressful economic scenarios as a form of sensitivity testing, it was not designed as a stress-test model, nor does it attempt to replicate the stress scenarios used by the OFHEO RBC stress test.

Determination of a "true" required risk-based capital level on GSE loan guarantees is

complicated by the fact that they engage in two lines of business (guarantees and mortgage investments) against which they hold a combined total amount of capital. A GSE is required by statute to hold a minimum of 45 basis points of total capital against off-balance sheet credit guarantees, and 250 basis points against on-balance sheet assets. Under the OFHEO risk-based capital (RBC) standard, a GSE may be required to hold more total capital than the total implied by these minimum capital requirements, or it may elect to do so based on its own economic capital calculations. In any event, it does not necessarily follow that the marginal and/or total capital requirements on GSE credit guarantees will exceed 45 basis points even when their total combined capital requirement exceeds the amount corresponding to pro rata application of the statutory minimums. This depends on the relative contributions of interest-rate risk and credit risk to their overall risk-based capital requirements. The issues of capital deployment and capital allocation engage a great deal of enterprise resources and are generally not publicly disclosed, and Freddie Mac offers no guidance on their actual policies and practices in this area in their comments.

The explicit assumption made in the RIA is that the true risk-based capital level for all GSE credit guarantees (on- or off-balance sheet) is less than or equal to an average of 45 basis points. That is, we assume the GSEs hold 45 basis points corresponding to the statutory minimum capital requirement on off-balance sheet assets, but we believe that economic capital levels are probably lower in total, particularly over the range of likely economic scenarios. By contrast, regulatory risk-based capital requirements, including the statutory minimums, presume severe or worst-case economic outcomes. Given the extremely low levels of GSE credit losses in recent years, the assumption that the statutory minimum of 45 basis points is a binding constraint is a quite reasonable assumption. Furthermore, since this level is assumed to exceed the amount of capital the GSEs would voluntarily hold against the risk of unexpected losses on credit guarantees, there was no need to speculate on how much additional capital they need to hold (on average) due to the increased risk, if any, associated with additional purchases of affordable loans.

Freddie Mac comments that the financial analysis should have employed a risk-neutral interest rate process, which they claim is imperative in any derivative pricing analysis. Although risk-neutral pricing is commonly used for valuing option-based instruments, it is not a common method for valuing mortgages in practice. Indeed, Option Adjusted Spread (OAS) analysis, probably the most common valuation method for mortgages, is not a risk-neutral model. To see this, consider that in a risk-neutral model all assets earn the risk-free rate, regardless of their risk level. The primary objective of an OAS model, or in the case here, the GAS model, is to find the spread above the risk-free rate that the mortgage price implies the asset is yielding. The fundamental premise of an OAS model is that it is not risk-neutral. Because of this reason, it is valid to use an econometrically estimated interest rate model such as the OTS model for this purpose. The following quotation from an article by Teri Geske helps to frame the issue:

> "Before moving on, let us clarify an important distinction between risk-neutral pricing of options and the pricing of corporate bonds, mortgage-backed securities and other risky assets. When determining the present value of risky cash flows, such as the payments on

a corporate bond where credit downgrades or defaults may occur, or for mortgage-backed securities where the timing of principal and interest payments is uncertain, we cannot assume that investors are indifferent to risk. We must adjust the discount rate applied to those cash flows to be greater than the risk-free rate; this is done by layering a spread (OAS) over the Treasury curve. The benefits of risk-neutral pricing apply only to options, because an option's payoff can be fully replicated with no uncertainty by combining other assets in the correct proportions. This was the vital insight of the Black-Scholes model."[62]

Prepayment Propensities of the GSE's Retained Portfolios Accurate. The financial analysis assumed from the outset that the only meaningful financial risk to GSE profitability from higher levels of goal-qualifying loans would be increased credit risks. Thus, the analysis made no attempt to assess the impact on the net-interest income component of the GSE operations. This would have entailed completely arbitrary assumptions about GSE funding and hedging strategies which are not publicly disclosed, and can be modified at any time by the enterprises. For purposes of illustration, the analysis computed OAS values on GSE mortgages to demonstrate the relatively modest differences in interest-rate-dependent behavior between baseline and additional goal-qualifying purchases. The results are consistent with the well-known finding that low-income loans are less sensitive to interest rates due to lower overall propensities to prepay. In terms of the potential impact on unscheduled principal payments received by mortgage investors, the estimated differences in OAS values are not large, which may be due to the fact that lower prepayment propensities are offset somewhat by higher default rates on low-income loans.

Freddie Mac makes additional comments regarding the application of the OFHEO loan performance models that again assume that the analysis applied models calibrated for a historically stressful economic environment. As mentioned above, this comment does not accurately describe the models that were used in the financial analysis, which are representative of GSE loan performance across a wide range of economic circumstances, and do not apply the calibration factors used in the OFHEO risk-based capital stress test.

High Guarantee Fees for Goal-Qualifying Purchases Appropriate. Freddie Mac comments that the analysis "makes unrealistic and unsupported assumptions about the guarantee fees (G-fee) that can be charged on the incremental goal qualifying purchases needed to meet the new goals." The particular schedule of guarantee fees by LTV was selected for consistency with the average levels of guarantee fees reported by Fannie Mae (18.8 bps) and Freddie Mac (18.5 bps) in their annual reports for 2001, and their reported overall LTV distributions. The goal was to apply a schedule of guarantee fees that would result in roughly the same overall weighted average guarantee fee. In fact, the resulting weighted average guarantee fees (18.5 bps for Freddie Mac and 18.8 bps for Fannie Mae), are slightly lower than the averages reported in their 2000 and 2001 annual reports. Freddie Mac cites a single transaction on which they claim they

[62] Teri Geski, "Back to Basics: Are Investors Really "Risk Neutral?"," On the Edge, CMS Bondedge Newsletter, July/August 1998.

paid such a large premium to purchase goal-qualifying loans that this resulted in an implied guarantee fee that was either very low or negative. However, Freddie Mac provided no information to indicate that they charge very low or negative guarantee fees on the majority of loan purchases or securitization transactions for goal-qualifying loans. It is unlikely that this is the case in general, since goal-qualifying loans have comprised an increasing share of all loan purchases since 1995 and there have only been modest year-to-year changes in average guarantee fees.

The results reported in the following sections and the model discussed in Appendix A are based on an analysis conducted by Charles A. Calhoun and Richard D. Buttimer under contract with the Urban Institute.

E.1. Summary of the Analysis

The GSEs engage in two primary business activities: (1) they provide credit guarantees on conventional conforming residential mortgages; and (2) they undertake investments in retained mortgages and mortgage-related securities. Under the credit guarantee business a GSE guarantees (insures) the timely payment of interest and return of principal to investors in mortgage-related securities. In return for insuring loans against the risk of borrower default a GSE receives income in the form of guarantee fees, and bears costs related to loan servicing expenses, administrative expenses, and potential losses on defaulting loans. The primary risk of this activity is higher than anticipated credit losses. The GSE's credit guarantees are off-balance sheet contingent liabilities. They are required to meet minimum and risk-based capital requirements on their off-balance sheet obligations to protect the corporations, and ultimately taxpayers, against the potential risk of extraordinarily large credit losses.

The mortgage investment business component entails purchasing mortgages and mortgage-related securities in the secondary market, which the GSEs fund by issuing debt securities in national and international debt markets. The GSEs earn net-interest income from the spread between the coupons on retained mortgages and the cost of their debt. The primary risk associated with the mortgage investment business is interest-rate risk due to changes in the "durations" of their assets and/or liabilities due to unexpected interest rate volatility. To manage their interest-rate risk the GSEs issue callable debt and engage in other forms of hedging and derivative activity. The GSEs are also required to meet minimum and risk-based capital requirements for their on-balance sheet investments. Credit risk on GSE mortgage investments is effectively insured by the credit guarantee business segment, for which the investment business pays an implicit guarantee fee.

It is primarily the credit guarantee business that is likely to be affected by the types of changes in the composition of GSE lending anticipated under the housing goals, including increased lending to low-income borrowers or borrowers residing in underserved areas (primarily lower income Census tracts and those with higher minority population percentages). The profitability of GSE credit guarantees may be reduced if loans to lower income borrowers or

those located in underserved areas have higher default and/or loss severity rates than other GSE loans, or if the GSEs are required to hold additional capital against these risks. Higher credit losses (after accounting for third-party credit enhancements such as private mortgage insurance) directly lower GSE profitability by reducing net income from their guarantee business, while higher minimum or risk-based capital requirements lower the rate-of-return on equity by requiring a higher initial capital investment at the same levels of net income.

GSE minimum and risk-based capital standards are set by statute and by regulations promulgated by the Office of Federal Housing Enterprise Oversight (OFHEO). OFHEO applies a number of financial models to project the future performance of GSE investments and credit guarantees to determine the corporations' risk-based capital requirements. However, OFHEO's quarterly financial calculations only apply to the GSE's existing portfolios and are simulated under a "wind-down" scenario under which an enterprise makes no new mortgage purchases. By contrast, changes in the housing goals affect the content and volume of future GSE mortgage acquisitions. Thus, the results from OFHEO's risk-based capital stress test do not assess the potential financial impact of a change in the housing goals.

Nevertheless, the analysis reported here and discussed in Appendix A has conceptual and methodological linkages to the OFHEO risk-based capital model. First, the analysis utilizes publicly available model components from the OFHEO Risk-Based Capital regulations—specifically the single-family and multi-family default and prepayment models and loss-severity assumptions. One important benefit of using these models and assumptions is that they were estimated using large databases of historical GSE loan performance that are otherwise unavailable for independent analysis, and they have been reviewed and commented on by the GSEs and other interested parties.

The 2004 profitability analysis also makes use of option-adjusted spread (OAS) calculations to estimate economic valuations of GSE credit guarantees and mortgage assets. Thus, while OFHEO's stress test model utilizes deterministic cash flow projections (as required by statute), the profitability analysis more closely resembles Wall Street valuation methods.

The primary focus of the 2004 profitability analysis is on GSE credit guarantees, which is the business component most likely to be affected by the housing goals. Potential differences in the prepayment performance of loans meeting the requirements of the housing goals may also have implications for GSE net-interest income investments if the duration of GSE assets would be adversely affected by the prepayment and default performance of loans to low-income borrowers or borrowers in underserved areas. However, most published evidence suggests that loans to low-income borrowers are actually more valuable as net-interest income investments (or as collateral for mortgage-related securities) due to their slower prepayment speeds. A more limited financial analysis of GSE mortgage assets is included to assess whether this outcome holds for GSE loans meeting the housing goals.

E.2. Summary of Key Findings

Additional targeted lending under the new housing goals is projected to have a negligible impact on the profitability of GSE credit guarantees and market valuations of GSE mortgage assets. In large measure, this is due to the fact that the baseline scenarios already include significant volumes of low-income loans and loans in underserved areas required under the goals. The increased lending to low-income borrowers and borrowers in underserved areas entails essentially the same highly profitable activity in which the GSE have been engaged over several years. This result holds over widely varying economic scenarios for single-family house price appreciation and multi-family rental rates applied in the financial analysis. Although the economic environment is projected to have a significant impact on the value of GSE credit guarantees, additional targeted lending under the housing goals is projected to perform in a manner similar to baseline loan purchases across all scenarios, and represents little additional risk to GSE profitability. However, as explained in Section C.4f of Chapter III, the GSEs, and particularly Freddie Mac, will have to reach deeper into the lower-income end of the mortgage market in order to attain the 2007 and 2008 goals; this will lead to lower, but still reasonable, financial returns for Freddie Mac.

Tables 6.8 and 6.9 summarize the results of financial simulations undertaken to compute the expected return-on-equity (ROE) of GSE credit guarantees under a range of future economic scenarios. Table 6.8 reports the results for Fannie Mae and Table 6.9 reports the results for Freddie Mac. The tables report expected ROE values for credit guarantees on loans secured by different types of single-family and multi-family properties: single-family owner occupied properties (SFO), single-family 1-4 unit owner occupied properties (SF14), single-family 2-4 unit rental properties (SF24), and multi-family (5 or more unit) rental properties (MF). Results are generated under three alternative economic scenarios for appreciation rates of single-family house prices: (1) 4-percent positive appreciation; (2) 2-percent positive appreciation; and (3) 2-percent negative appreciation; and three corresponding scenarios for changes in multi-family unit rental rates: (1) 0-percent; (2) 3-percent negative; and (3) 6-percent negative growth rates.

TABLES 6.8 AND 6.9

Two sets of results are shown in each summary table: (1) results based on unadjusted loan performance models; and (2) results based on adjusted loan performance models. The first set of results is based on application of published OFHEO loan performance models estimated using Fannie Mae and Freddie Mac historical loan performance data from the 1980s and 1990s. The second set of results is based on the same underlying models, but where the conditional default rates are increased and REO proceeds (i.e., proceeds on real estate owned by a financial institution after foreclosure) are decreased for low-income loans and loans secured by properties located in underserved areas. These adjustments are intended to simulate a hypothetical degradation in loan performance in the event the GSEs need to adopt less restrictive underwriting standards in order to comply with the housing goals regulations. As explained in Chapter III, Freddie Mac, in particular, will have to significantly increase its goals-qualifying

Table 6.8

Expected Return-on-Equity (ROE) for GSE Credit Guarantees
Fannie Mae
Results Based on Unadjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	31.44	31.47	25.18	40.86	Baseline	29.64	30.99	24.88	40.36
Additional	28.20	35.00	26.08	40.20	Additional	28.11	34.88	26.11	40.13

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	28.01	28.28	22.96	40.87	Baseline	25.86	27.58	22.62	40.37
Additional	23.96	32.52	24.04	40.21	Additional	23.81	32.32	24.10	40.14

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	11.82	12.06	10.82	40.42	Baseline	10.56	11.56	10.63	39.91
Additional	10.30	14.39	11.78	39.81	Additional	10.04	14.14	11.90	39.78

Results Based on Adjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	28.99	23.86	19.48	40.85	Baseline	22.55	21.21	16.13	40.35
Additional	21.75	30.44	21.71	40.22	Additional	20.12	30.11	21.11	40.14

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	25.73	20.96	17.36	40.71	Baseline	19.30	18.24	14.15	40.06
Additional	18.48	27.72	19.46	40.20	Additional	17.07	27.30	18.86	40.12

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	11.78	11.57	11.65	22.59	Baseline	10.49	11.01	11.88	12.13
Additional	10.52	12.88	12.33	15.94	Additional	10.35	12.56	12.53	14.53

Table 6.9

Expected Return-on-Equity (ROE) for GSE Credit Guarantees
Freddie Mac
Results Based on Unadjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	31.33	30.74	24.77	34.89	Baseline	29.01	30.08	24.07	36.08
Additional	28.54	30.61	24.19	35.89	Additional	28.34	30.44	24.27	35.74
Total	31.07	30.69	24.67	35.08	Total	28.85	30.16	24.11	36.01

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	28.14	27.78	22.53	31.89	Baseline	25.32	26.85	21.68	33.78
Additional	24.81	27.38	21.87	33.51	Additional	24.49	27.24	21.93	33.22
Total	27.83	27.68	22.42	32.20	Total	25.12	26.93	21.73	33.66

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	12.50	12.37	10.77	7.88	Baseline	11.00	11.81	10.50	8.28
Additional	11.13	11.48	10.29	7.79	Additional	10.84	11.99	10.59	8.40

Results Based on Adjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	29.22	24.08	19.27	29.60	Baseline	22.20	21.05	15.34	28.07
Additional	22.44	23.21	17.25	30.00	Additional	21.09	22.03	16.05	27.75

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	26.23	21.35	17.19	19.61	Baseline	19.21	18.25	13.39	15.44
Additional	19.50	20.13	15.09	19.80	Additional	18.24	19.15	14.03	13.93

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	12.62	12.80	11.72	7.53	Baseline	11.44	12.45	12.04	7.26
Additional	11.63	11.44	11.47	8.06	Additional	11.46	12.45	12.03	8.36

purchases of both single-family-owner and multifamily loans in order to meet the out-year (2007 and 2008) goal targets. This could require them to relax their underwriting standards somewhat.

Tables 6.8 and 6.9 report expected ROE values on an after-tax basis. Expected ROE values under Scenario 1 are approximately 31 percent for loans secured by single-family owner-occupied (SFO) properties. These rates are generally consistent with the overall ROEs reported by the GSEs in their annual financial disclosures, and indicate that the OFHEO models produce results consistent with the recent economic performance of the GSEs under similar economic circumstances. Projected ROE values for loans secured by multifamily properties, which are not reported separately in GSE financial disclosures, are slightly higher—40 percent for Fannie Mae and 36 percent for Freddie Mac. Although the analysis could not independently verify whether these profit rates are representative of actual GSE financial performance on multi-family loans, they are consistent with somewhat higher guarantee fees, extensive loss-sharing arrangements, and the generally conservative approach to underwriting applied to this component of their guarantee businesses.

Tables 6.10 and 6.11 report the average lifetime cumulative default rates corresponding to each of the loan portfolios and economic scenarios underlying the results in Tables 6.8 and 6.9. The three economic scenarios produce substantially different loan performance outcomes, and these are magnified under the results for the adjusted default rate models in the bottom panel of each table. Although single-family default rates on additional targeted lending are significantly greater than default rates on baseline purchases under the most stressful scenarios, this does not translate directly into the same relative differences in ROE values because of higher guarantee fees and higher mortgage insurance coverage ratios on high LTV loans.

TABLES 6.10 AND 6.11

The analysis did not value GSE net-interest income investments (defined as purchased mortgage loans held in portfolio, net of credit guarantees). The relative risk of these investments ultimately depends on the interaction of loan performance with the dynamic funding and hedging strategies of the enterprises, of which there is limited public disclosure. However, it is possible to address the question of whether additional targeted lending requires acquisition of loans with substantially lower value as "mortgage assets." Starting from a buy-and-hold-to-maturity perspective and assuming all loans are purchased at par, the analysis computed option-adjusted spread (OAS) values across the same loan stratifications used in comparing ROE values on GSE credit guarantees. The resulting OAS values were used to assess the relative values of different mortgage categories in relation to risk-free zero-coupon bonds.

Tables 6.12 and 6.13 report the average OAS values based on the same loan stratifications. Higher OAS values indicated relatively higher valuations. The primary source of differences in the OAS valuations is the interest-rate sensitivity of the underlying mortgage assets—either they are less likely to prepay during declining rate environments, or they are more likely to prepay during increasing rate environments, making them less sensitive overall to interest rate volatility. The results indicate, in general, slightly lower OAS values for additional

Table 6.10

Lifetime Cumulative Default Rates
Fannie Mae
Results Based on Unadjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	0.81	0.78	1.43	0.94	Baseline	0.95	0.82	1.48	1.06
Additional	1.10	0.57	1.30	1.12	Additional	1.13	0.58	1.29	1.13

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	1.15	1.06	1.70	1.78	Baseline	1.38	1.14	1.78	2.00
Additional	1.68	0.74	1.51	2.13	Additional	1.72	0.75	1.50	2.14

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	3.93	3.69	6.18	9.25	Baseline	4.64	3.88	6.45	10.20
Additional	5.42	2.65	5.54	11.44	Additional	5.52	2.71	5.50	11.53

Results Based on Adjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	1.04	1.43	2.32	1.61	Baseline	1.63	1.67	2.91	2.14
Additional	1.84	0.85	1.85	1.65	Additional	2.06	0.87	1.92	1.68

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	1.48	1.94	2.74	3.02	Baseline	2.35	2.29	3.46	3.98
Additional	2.78	1.09	2.14	3.12	Additional	3.12	1.12	2.22	3.18

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	4.88	6.23	9.21	14.37	Baseline	7.41	7.17	11.27	18.06
Additional	8.39	3.78	7.49	15.99	Additional	9.25	3.89	7.72	16.34

Table 6.11

Lifetime Cumulative Default Rates
Freddie M ac
Results Based on Unadjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	0.80	0.79	1.46	1.39	Baseline	0.98	0.83	1.56	1.12
Additional	1.02	0.82	1.56	1.16	Additional	1.05	0.81	1.53	1.20

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	1.12	1.05	1.72	2.92	Baseline	1.42	1.13	1.85	2.29
Additional	1.49	1.12	1.85	2.37	Additional	1.55	1.10	1.81	2.46

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	3.87	3.69	6.45	15.44	Baseline	4.81	3.92	6.91	12.06
Additional	5.02	3.95	6.89	12.30	Additional	5.17	3.84	6.73	12.93

Results Based on Adjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	1.01	1.40	2.37	2.15	Baseline	1.68	1.68	3.08	2.23
Additional	1.69	1.47	2.69	2.00	Additional	1.87	1.56	2.92	2.31

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	1.43	1.86	2.78	4.42	Baseline	2.43	2.25	3.64	4.47
Additional	2.48	1.99	3.17	4.04	Additional	2.74	2.10	3.44	4.66

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	4.76	6.11	9.60	20.99	Baseline	7.71	7.21	12.16	20.26
Additional	7.82	6.56	10.86	18.56	Additional	8.54	6.84	11.51	21.08

targeted lending for single-family owner-occupied (SFO) and multi-family (MF) mortgages, and slightly higher OAS values for single-family 1-4 owner-occupied (SF14) and single-family 2-4 unit rental (SF24) properties. Additional targeted lending has virtually no impact—generally less than 1 basis point—on the overall average OAS values for total lending on each property type. This indicates that additional targeted lending under the final housing goals is not an additional source of financial risk for GSE net-interest income investments.

TABLES 6.12 AND 6.13

E.3. Conclusions

The primary objective of this analysis was to assess whether the GSEs will earn reasonable rates of return on additional targeted lending under the revised housing goals. The GSEs have earned high returns on both their baseline and targeted purchases. The analysis applied mortgage default and prepayment models developed from GSE historical loan performance data covering a period of nearly 20 years. To account for potential structural changes in mortgage risk associated with more aggressive underwriting in pursuit of loans that qualify under the goals, the analysis also looked at outcomes based on adjusted models in which mortgage default rates are increased and REO sales proceeds are decreased on low-income loans and loans in underserved areas. Results based on the adjusted loan performance models are generally consistent with those based on the unadjusted models. (See Chapter 3 for a discussion of the effect of the higher goal levels on the ROEs of targeted business and the likely ROE effect on overall business.) The analysis concludes that the GSEs will not experience any significant deterioration in the profitability of their credit guarantee business under the new housing goals.

These findings parallel the results of previous financial analyses of changes to the housing goals in 1995 and 2000. One significant difference between the current and previous analyses is the increased level of detail in valuing GSE credit guarantees. Appendix A includes additional detailed tabulations underlying the summary tables presented here.

Table 6.12

Option-Adjusted Spread (OAS) Values
Fannie Mae
Results Based on Unadjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	449.61	450.38	424.34	494.61	Baseline	445.63	450.53	423.44	495.17
Additional	443.17	461.70	428.90	503.13	Additional	443.35	461.52	429.12	503.39

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	446.85	448.01	423.71	496.27	Baseline	442.48	447.91	422.81	496.38
Additional	439.28	460.01	428.37	503.75	Additional	439.41	459.75	428.61	503.93

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	433.54	436.15	418.18	500.29	Baseline	429.28	436.05	417.57	499.67
Additional	426.09	447.55	422.68	506.37	Additional	426.18	447.14	423.03	506.43

Results Based on Adjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	449.92	451.32	425.55	494.88	Baseline	446.55	451.74	425.38	495.59
Additional	444.11	462.14	429.67	503.29	Additional	444.53	461.98	430.00	503.56

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	447.31	449.33	425.16	496.77	Baseline	443.85	449.62	425.15	497.13
Additional	440.76	460.59	429.26	504.03	Additional	441.29	460.36	429.63	504.22

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	435.34	441.28	423.88	502.45	Baseline	434.54	442.67	426.68	502.72
Additional	431.39	450.16	426.39	507.61	Additional	432.85	449.86	427.28	507.74

Table 6.13

Option-Adjusted Spread (OAS) Values
Freddie Mac
Results Based on Unadjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	439.27	430.88	417.70	424.61	Baseline	432.67	427.94	412.16	452.94
Additional	431.07	438.05	414.12	451.80	Additional	431.06	430.54	413.90	449.65

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	436.76	428.92	417.15	429.19	Baseline	429.65	425.75	411.59	456.33
Additional	427.98	435.90	413.52	455.42	Additional	427.83	428.36	413.35	453.20

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	424.51	418.07	411.97	444.72	Baseline	417.56	415.08	407.04	466.93
Additional	416.13	424.74	408.56	466.34	Additional	415.87	417.32	408.73	464.76

Results Based on Adjusted Loan Performance Models

Economic Scenario 1

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	439.56	431.81	418.91	425.36	Baseline	433.64	429.21	414.20	453.96
Additional	431.99	439.03	415.64	452.58	Additional	432.16	431.69	415.77	450.68

Economic Scenario 2

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	437.20	430.18	418.58	430.69	Baseline	431.08	427.49	414.03	458.34
Additional	429.36	437.24	415.33	456.97	Additional	429.49	429.93	415.56	455.24

Economic Scenario 3

All Areas					Underserved Areas				
	SFO	SF14	SF24	MF		SFO	SF14	SF24	MF
Baseline	426.17	422.98	417.67	450.40	Baseline	423.01	421.77	416.53	474.28
Additional	421.24	430.03	415.72	472.07	Additional	422.01	423.47	417.37	472.15

Appendix A to Chapter VI

Methodology, Models, and Parameters

This Appendix discusses the methodology, models, and parameters used to analyze the GSEs' profits under the increased housing goals.

Introduction

The GSEs engage in two primary business activities: (1) they provide credit guarantees on conventional conforming residential mortgages; and (2) they undertake investments in retained mortgages and mortgage-related securities. Under the credit guarantee business a GSE guarantees (insures) the timely payment of interest and return of principal to investors in mortgage-related securities.[1] In return for insuring loans against the risk of borrower default a GSE receives income in the form of guarantee fees, and bears costs related to loan servicing expenses, administrative expenses, and potential losses on defaulting loans. The primary risk of this activity is higher than anticipated credit losses. The GSE's credit guarantees are off-balance sheet contingent liabilities. They are required to meet minimum and risk-based capital requirements on their off-balance sheet obligations to protect the corporations, and ultimately taxpayers, against the potential risk of extraordinarily large credit losses.[2]

The mortgage investment business component entails purchasing mortgages and mortgage-related securities in the secondary market, which the GSEs fund by issuing debt securities in national and international debt markets. The GSEs earn net-interest income from the spread between the coupons on retained mortgages and the cost of their debt. The primary risk associated with the mortgage investment business is interest-rate risk due to changes in the "durations" of their assets and/or liabilities due to unexpected interest rate volatility.[3] To manage their interest-rate risk the GSEs issue callable debt and engage in other forms of hedging and derivative activity. The GSEs are also required

[1] Examples of mortgage-related securities backed by mortgage loans and guaranteed by the GSEs include: single-class mortgage-backed securities (MBS), multi-class mortgage-backed securities such as real estate mortgage investment conduits (REMICs) or collateralized mortgage obligations (CMOs), derivative mortgage-backed securities such as interest-only (IO) and principal-only (PO) strips, and senior-subordinate structured securities issued by private entities, and mortgage revenue bonds (MRBs) issued by state and local governments.

[2] The Office of Federal Housing Enterprise Oversight (OFHEO) has developed and published minimum and risk-based capital regulations for the GSEs. OFHEO is the primary agency responsible for the financial safety and soundness regulation of the GSEs.

[3] Asset "duration" is formally defined in terms of the impact on the value of a bond in response to small changes in interest rates, but may also be interpreted as the average time of receipt of discounted cash flows from the bond. The duration of a mortgage or mortgage-backed security increases or lengthens with an increases in interest rates because prepayment rates decline, which has a cost to the investor since the same cash flows are now discounted at higher rates and they would prefer to be investing in more current higher yield instruments. The duration of a mortgage decreases or shortens as interest rates fall due to increasing prepayment speeds, which also has an opportunity cost to investors since principal is returned ahead of schedule and can only be reinvested in instruments paying currently lower rates.

to meet minimum and risk-based capital requirements for their on-balance sheet investments. Credit risk on GSE mortgage investments is effectively insured by the credit guarantee business segment, for which the investment business pays an implicit guarantee fee.[4]

It is primarily the credit guarantee business that is likely to be affected by the types of changes in the composition of GSE lending anticipated under the housing goals, including increased lending to low-income borrowers or borrowers residing in underserved areas (primarily lower income Census tracts and those with higher minority population percentages). The profitability of GSE credit guarantees may be reduced if loans to lower income borrowers or those located in underserved areas have higher default and/or loss severity rates than other GSE loans, or if the GSEs are required to hold additional capital against these risks. Higher credit losses (after accounting for third-party credit enhancements such as private mortgage insurance) directly lower GSE profitability by reducing net income from their guarantee business, while higher minimum or risk-based capital requirements lower the rate-of-return on equity by requiring a higher initial capital investment at the same levels of net income.

GSE minimum and risk-based capital standards are set by statute and by regulations promulgated by The Office of Federal Housing Enterprise Oversight (OFHEO). OFHEO applies a number of financial models to project the future performance of GSE investments and credit guarantees to determine the corporations' risk-based capital requirements. However, OFHEO's quarterly financial calculations only apply to the GSE's existing portfolios and are simulated under a "wind-down" scenario under which an enterprise makes no new mortgage purchases By contrast, changes in the housing goals affect the content and volume of future GSE mortgage acquisitions. Thus, the results from OFHEO's risk-based capital stress test do not assess the potential financial impact of a change in the housing goals.

Nevertheless, the analysis reported here has conceptual and methodological linkages to the OFHEO risk-based capital model. First, the analysis utilizes publicly available model components from OFHEO regulations—specifically the single-family and multi-family default and prepayment models and loss-severity assumptions. One important benefit of using these models is that they were estimated using large databases of historical GSE loan performance that are otherwise unavailable for independent analysis, and they have been vetted through the federal rulemaking process, including review and commentary by the GSEs and other interested parties.

The analysis reported here also differs from OFHEO's in important ways, most notably by the use of option-adjusted spread (OAS) calculations to estimate economic valuations of GSE credit guarantees and mortgage assets. Thus, while OFHEO's stress

[4] Some have criticized the GSEs for accounting for guarantee fees on retained mortgage investments as income to their guarantee business, in an apparent attempt to inflate returns on this business segment. However, this criticism is without merit, since there is an equal and offsetting impact to net-interest income on their retained mortgage investments.

test model utilizes deterministic cash flow projections (as required by statute), this profitability analysis more closely resembles Wall Street valuation methods.

Although OAS analysis was applied in the earlier financial analyses of the affordable lending goals conducted in 1995 and 2000, the current analysis makes several significant improvements. One of these is the increased level of detail under which the expected financial performance of GSE loans classified as meeting the targeted lending criteria are reported, both with regard to the loan-level data and the application of the OAS methodology to specific subcomponents of GSE loan portfolios. Another significant innovation is the economic assumption used to initialize the OAS valuation procedure. Although GSE credit guarantees are not traded in the market and have no observed market prices, to engage in the credit guarantee business a GSE must hold a minimum level of economic or regulatory capital. Since debt funding is irrelevant in the case of an off-balance sheet asset, the initial equity investment may be viewed as the price paid to acquire the risk exposure. Given the initial price, we can apply OAS analysis to value GSE credit guarantees in same manner as other mortgage-related assets like mortgage servicing rights (MSRs).

The primary focus of this profitability analysis is on GSE credit guarantees, which is the business component most likely to be affected by the housing goals. Potential differences in the prepayment performance of loans meeting the requirements of the housing goals may also have implications for GSE net-interest income investments if the duration of GSE assets would be adversely affected by the prepayment and default performance of loans to low-income borrowers or borrowers in underserved areas. However, most published evidence suggests that loans to low-income borrowers are actually more valuable as net-interest income investments (or as collateral for mortgage-related securities) due to their slower prepayment speeds.[5] This analysis undertakes a more limited financial analysis of GSE mortgage assets to confirm that this outcome holds for GSE loans meeting the housing goals.

Specific Objectives of the Analysis

The primary objective of the financial analysis was to assess the relative profitability "targeted" loan purchases and their potential impact on GSE profit rates. Loan purchase assumptions include baseline loan purchases, which are those that the GSEs would undertake even if there were no changes in the housing goals, and additional targeted lending required to meet the new housing goals. The loan purchase information was stratified by three single-family property types and for multifamily properties. The three single-family property types are: (1) single-family owner occupied properties; (2) single-family 1-4 unit owner-occupied rental properties; and (3) single-family 2-4 unit rental properties. The single-family purchase information was further stratified by classifications for relative income (6 categories) and LTV (4 categories). Multifamily properties are rental properties with 5 or more units. Multifamily purchases were

[5] See N. Brown and D. Westoff, "Packaging CRA Loans into Securities," *Mortgage Banking*, 8(58):32-41, May 1998. The authors discuss differences in prepayment speeds of mortgage loans meeting the requirements of the Community Reinvestment Act (CRA) and other low-income mortgage loans.

stratified by classifications for relative income. Using separate tables for the number of housing units and average mortgage amounts, tables were created for original loan balances.

The present analysis improves on earlier studies by exploiting significantly more detail on GSE loan characteristics and performance.[6] The primary source of loan detail is loan-level data which the GSEs submit to the Department on an annual basis. The loan-level data provide a detailed snapshot of recent GSE loan acquisitions, including information on loan product types, key underwriting variables such as loan-to-value (LTV) ratios, and variables specifically related to the housing goals, such as borrower income, area median income, and whether the loan was issued in a Census tract classified as low-income or "underserved."

The future performance of prospective GSE loan purchases was projected using OFHEO's publicly available statistical models of GSE single-family and multi-family mortgage default and prepayment.[7] The OFHEO models were published in the Federal Register as part of their final risk-based capital rule and were originally estimated using historical loan-level data from the GSEs.

Assessing the impact of differences in loan performance on GSE profitability ultimately requires more than simple comparisons of mortgage default and loss rates, particularly for mortgages that have yet to be originated. The accepted industry approach to mortgage valuation is option-adjusted spread (OAS) analysis (see above discussion of OAS analysis).

Overview of Modeling Approach

The main elements of the financial modeling approach are outlined in Exhibit 1. The overall strategy was to utilize loan-level information on recent GSE mortgage acquisitions, apply previously estimated statistical models to project the future performance of GSE loans, and evaluate the financial implications of loan performance under different economic scenarios.

The primary source of information on the detailed characteristics of new loan originations was the loan-level GSE data. Loan performance is projected by applying models published by OFHEO. The GSE data used in this analysis was modified to

[6] Similar analyses were undertaken in 1995 and 2000 when the Department proposed new housing goals for the GSEs. See "Economic Analysis for The Secretary of HUD's Regulation of The Federal National Mortgage Association (Fannie Mae) and The Federal Home Loan Mortgage Corporation (Freddie Mac)," U.S. Department of Housing and Urban Development, Office of Policy Development and Research, November 1, 1995 and August 22, 2000.

[7] See U.S. Department of HUD, Office of Federal Housing Enterprise Oversight, "Risk-Based Capital; Final Rule," Federal Register, Vol. 66, No. 178, pp. 47730-47875, Thursday, September 13, 2001. OFHEO has subsequently issued several changes, corrections, and amendments to the RBC rule. These documents are available via the internet at http://www.gpoaccess.gov/multidb.html.

conform to the data aggregations used by OFHEO as input to their loan performance models.

Following aggregations of the GSE loan origination data to conform to the OFHEO model requirements, the next step is to construct quarterly loan event histories capturing the period-to-period changes in loan status and dynamic factors affecting loan performance. The main drivers of single-family loan performance in the OFHEO models are house price appreciation rates and diffusion volatilities and changes in interest rates. These factors influence the values of borrower default and prepayment options. Additional details on the models are reported in OFHEO's published regulations.

The GSE loan-level data provide a detailed snapshot of GSE loan acquisitions for each calendar year. This analysis assumed the mix of loan "types" found in the GSEs' recent purchase data will be representative of future loan purchases, although the total volume of specific loan categories meeting the goals may differ significantly. This assumption allows the analysis to project the financial performance for the various loan types one time (per economic scenario), and then to apply alternative weighting schemes to match the loan balances implied by purchase assumptions under the new goals.

A re-weighting procedure was implemented to make the results based on analysis of the loan-level GSE data align with purchase assumptions about future GSE loan acquisitions. Loan groupings were defined using purchase assumptions by classifications for borrower income relative to area-median-income, LTV, property type, and underserved area classifications. Class weights were assigned based on the share of each loan group's original loan balance to the total original loan balance. An identical classification structure was applied to the GSE loan-level data (more accurately, the loan aggregations based on these data) and class weights and total original balances were computed for these recent purchases. Following computation and storage of all of the class-specific economic valuations, the assumed class weights were applied to rescale the loan balances within each class and the total portfolio loan balance to match the purchase assumptions. All subsequent tabulations of ROE values (Tables 6.8 and 6.9), cumulative default rates (Tables 6.10 and 6.11), and OAS values (Tables 6.12 and 6.13) are then based on the updated loan balances.

Loan Performance Models

The loan performance models reported in OFHEO's final risk-based capital rule for Fannie Mae and Freddie Mac were estimated using several years of combined loan-level data from the GSEs for the period 1979-97. In this regard, the basic loan performance data is much more up-to-date and representative of GSE loan performance than the estimates based on Freddie Mac data for 1975-83 that were applied in the 1995 and 2000 economic analyses.

OFHEO reported model coefficients for both default and prepayment jointly estimated on GSE historical data for single-family loans. OFHEO also develops single-family loss severity assumptions that take into account requirements for mortgage

insurance on high LTV loans. Prepayment assumptions applied in the OAS simulations for the 1995 and 2000 financial analyses relied on the OTS prepayment model, which is a Wall Street-type model that implicitly includes both actual payoffs and payoffs to investors in mortgage-related securities that result from defaulted loans that are repurchased by a guarantor. Use of a single set of models in which default and prepayment are jointly estimated makes the OAS loan performance assumptions consistent with those used in the profitability calculations, and more consistent with actual GSE historical loan performance.

Single-Family Loan Performance

The OFHEO single-family loan performance models account for different loan product types. OFHEO reports separate model estimates for different single-family product types, including: (1) 30-year FRMs; (2) ARMs; and (3) a multi-product equation including 30-year FRM, 15-year FRM, balloon loans, and government loans. Given the relative affordability of ARM loans, accounting for differences in their prepayment and default performance, it will be possible to improve both the specificity of the simulations and their accuracy with regard to different product types and economic scenarios.

The analysis applied loss severity assumptions similar to those used in the OFHEO risk-based capital model to generate total credit losses by month for each month of the cash flow simulations. In the OFHEO model losses are projected to occur in the same month as default, but still include the appropriate income and expenses resulting from the subsequent costs of foreclosure, sale of the security property, and receipt of MI proceeds (if any). Assuming that the losses are realized at the time of default simplifies the calculations with little impact on projected relative loan performance.

The OFHEO single-family loss model distinguishes between: (1) gross loss amount equal the sum of (i) the unpaid loan balance, (ii) interest accrued during the months the loan was delinquent prior to initiation of foreclosure proceedings, (iii) foreclosure costs, and (iv) REO expenses, minus the proceeds from the sale of the REO property; and (2) MI claim amount equal to the sum of (i) the unpaid loan balance, (ii) interest accrued from all missed payments through the completion of foreclosure; and (iii) foreclosure costs.[8]

In practice, the following scenarios may arise from the existence of MI:

(1) The servicer or insured (in this case a GSE) takes title to the property through foreclosure or by voluntary conveyance (e.g., deed in lieu of foreclosure), and

    (i) The servicer/insured sells at a loss with MI approval (pre-claim sale) and the MI pays the shortage (relative to the MI claim amount), or;

[8] Note that interest accrued by delinquent loans is limited by the time the loan can be delinquent before foreclosure proceedings are initiated. For loans backing mortgage-related securities this is usually limited to 90 days, by which time the guarantor is required to repurchase the loan from the security pool.

(ii) The servicer/insured sells at a profit and the MI pays nothing, or;

(iii) The servicer/insured submits a claim and the MI elects to either:

(a) Pay the percent liability implied by the coverage ratio, or;

(b) Pay the servicer/insured the full MI claim amount and take title to the REO property. In this case the MI provider markets the property and negotiates and closes the sale; or

(2) The property is sold by the borrower, and

(i) The borrower makes a full payoff; or

(ii) The MI approves sale of the property at a loss and the MI pays the shortage to the servicer/insured.

The analysis then applied the OFHEO single-family loss assumptions corresponding to scenario (1)(iii)(a) above—where the GSE submits a claim, the MI elects to pay the percent liability implied by the coverage ratio, and the GSE retains title to the REO property. Net losses were determined by the difference between the gross loss amount and any MI payments. In this case, the MI bears the initial percentage loss, and the GSE retains title to the REO property and receives the proceeds from the REO sale. MI coverage ratios are set at origination based on requirements that depend on the original LTV of the loan. The rates applied in the analysis are based on standard GSE required coverage levels.[9]

The OFHEO single-family loss model assumes that REO proceeds will be a constant proportion (61 percent) of the predicted average market price of properties that had the same initial value as the property securing the defaulted loan. The predicted average market prices of properties are determined by inflating the initial house value by the series of inflation factors implied by the house price scenario used in the simulation of loan performance. Thus, REO proceeds will be higher under scenarios where house price appreciation is greater, and lower under scenarios where house price appreciation is lower or negative.[10]

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[9] For example, Mortgage Guarantee Insurance Corporation (MGIC), one of the largest MI providers in the country, includes the standard GSE coverage requirements and maximum exposure levels on their standard pricing tables published on the MGIC web site (www.mgic.com). Standard GSE coverage ratios (CR) and exposure levels (EL) for 30-year fixed-rate mortgages by LTV are: 95 LTV (CR=30%, EL=67%), 90 LTV (CR=25%, EL=68%), 85 LTV (CR=12%, EL=75%). Required coverage ratios and exposure levels are the same for 25-year FRMs, but provided at lower monthly premiums to borrowers, while for 15- and 20-year loans required coverage ratios are lower, exposure levels are higher, and premiums are lower.

[10] Studies of the effect of foreclosure status on selling prices indicate that REO properties are sold at an average discount of 23 or 24 percent relative to their market value. See F.A. Forgey, R.C. Rutherford, and M.L. VanBuskirk, "Effect of Foreclosure Status on Residential Selling Price," Journal of Real Estate Research, 9(3):313-318, 1994; and J.D. Shilling, J.D. Benjamin, C.F. Sirmans, "Estimating Net Realizable Value for Distressed Real Estate," Journal of Real Estate Research, 5(1):129-140, 1990. The 61 percent

Generally, REO proceeds will not be sufficient to cover all of the actual costs associated with a defaulted loan and the MI payments will help to make up the short fall. However, the higher MI coverage ratios on high LTV loans may result in losses that are less than losses on lower LTV loans, even though the default rates on high LTV loans are higher. It is theoretically possible for a GSE to realize a net gain on a defaulting loan following the sale of the REO property, whether or not the loan has MI coverage. However, OFHEO assumes that gross losses are never less than zero, which implies that the maximum net gain is limited by the amount of the MI payment.

In practice, third-party credit enhancements employed by the GSEs include such features such as loan and/or aggregate loss limits, and other forms of loss sharing. OFHEO applies these features in its risk-based capital models, using detailed information reported by the GSEs in their quarterly data submissions to OFHEO. The analysis assumed that standard mortgage insurance coverage terms apply to all single-family loans.

The assumption that the GSE is always able to submit an MI claim and retain title to the REO property results in outcomes where the profitability of loan guarantees on 80-90 LTV and 90+ LTV loans may be higher than on 60-80 LTV loans under the most severe house price scenario. Likewise, the profitability of above 80 LTV loans may be higher under the most severe scenario than for the same loans under the more favorable house price scenarios. This result arises from differences in the timing of losses and MI claims, and the relative magnitude of REO recovery rates. In these cases the combined benefits of MI payments and REO proceeds offset some of the additional losses associated with higher LTV loans. This effect is magnified under scenarios where we impose assumptions of higher default rates on low-income loans and loans in underserved areas under the same array of house price scenarios and gross loss recovery rates.

MI coverage (or some other form of third-party credit enhancement) is required on any loan with origination LTV greater than 80 percent. Recent legislation requires that the lender terminate MI coverage requirement when the current LTV falls to 78 percent.[11] This rule is applied in the simulations in this analysis by eliminating MI

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recovery factor used by OFHEO, corresponding to a higher discount relative to market price of 39 percent, was based on analysis of observed losses and house price performance in the historical benchmark loss experience used by OFHEO to establish the rates of default and losses for their risk-based capital stress test. The OFHEO model uses this recovery factor to generate REO proceeds as a fraction of UPB at default. Thus, if UPB at default is 61 percent of the projected average market price (for homes that had the same value at origination) REO proceeds are 100 percent of UPB. If UPB at default is 100 percent of the projected average market price, then REO proceeds are only 61 percent of UPB. For a loan originated at 80 LTV, assuming zero house price appreciation and no change in loan balance, REO proceeds would be about 76 percent of UPB, which, ignoring other costs corresponds roughly to a loss severity of 24 percent.

[11] The Homeowner Protection Act of 1998, which became effective July 1999, included provisions to allow borrowers to drop mortgage insurance coverage under certain conditions. Lenders must release borrowers from the requirement to purchase mortgage insurance at the borrower's request once the balance of the loan is reduced to 80 percent of the original house value. When the loan balance declines to 78 percent of the original house value automatic termination is required.

coverage when the current LTV falls to 78 percent or lower, where current LTV is computed using the ratio of the amortized loan balance to the original house value.[12]

Multifamily Loan Performance

A similar approach was used in applying the OFHEO models to project the performance of multifamily loan performance. The OFHEO multifamily were developed by OFHEO from historical mortgage information provided by the enterprises. They differ from the single-family models in certain key respects: (1) they are monthly models, so there is no need to transform from quarterly to monthly termination factors before applying the projected default and prepayment probabilities to generate mortgage cash flows; (2) multifamily prepayment rates are not generated by a statistical model, but follow a set of rules for the impact of yield maintenance and prepayment penalties that limit prepayments for a specified period of time; and (3) the primary drivers of mortgage default outcomes are rental growth rates, rather than property value indexes as in the case of single-family loans.

Fannie Mae and Freddie Mac take different approaches to the management of credit risk in their multifamily programs.[13] Fannie Mae makes extensive use of risk sharing arrangements in its DUS product line. As a result, Fannie Mae actually bears very little credit risk exposure on multifamily loans.[14] Fannie Mae DUS lenders provide first loss coverage on a set percentage of the original principal balance and share any additional losses with Fannie Mae. For example, under the most common loss sharing arrangement, the lender will bear 100 percent of losses up to an amount equal to 5 percent of the original principal balance, 25 percent of additional losses for losses up to 20 percent of the original principal balances, and 10 percent of any additional losses, subject to a maximum lender loss of 20 percent of the original principal balance.[15] These loss-sharing assumptions were applied to all Fannie Mae loans in the financial analysis.

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[12] Note that "current LTV" as used here is a different measure than the one applied to determine REO proceeds. The latter depend on the relationship between the projected mean level of the house price index and UPBs on defaulting loans.

[13] An overview of commercial MBS underwriting and ratings guidelines is available from the Commercial Mortgage Securities Association website: http://www.cmbs.org/about/CMBS_OVR.pdf. This document also provides base-case credit enhancement guidelines for various property types, including multifamily properties. For example, the individual loan coverage ratios required for 70 LTV, 1.35 DCR multifamily loans are: 23.9 percent for AAA, 17.7 percent for AA, and 13.1 percent for A.

[14] GSE multi-family underwriting requirements and other aspects of the multifamily market are discussed in K. Burnett, and L.B. Fosburg, "Study of Multifamily Underwriting and the GSEs' Role in the Multifamily Market," Abt Associates, Inc., August 2001.

[15] GSE loss sharing arrangements and their use of various forms of credit enhancements in their single- and multi-family programs are described in K. Burnett, C.E. Herbert, and B. Maris, "Study of the Use of Credit Enhancements by Government Sponsored Enterprises: Final Report," Abt Associates, Inc., February 2001.

Economic Scenarios

For single-family loans, economic scenarios are represented by three different annualized rates of house price appreciation: (1) 4-percent positive appreciation; (2) 2-percent positive appreciation; and (3) 2-percent negative appreciation. These appreciation rates were applied in conjunction with the stochastic interest rate paths to generate the alternative cash flow vectors over which OAS valuations of GSE credit guarantees and mortgage assets are computed. The different appreciation rates are used to update the relevant borrower equity variables when constructing the quarterly event history data for input to the default and prepayment models.

For multi-family loans, economic scenarios are represented by three different annualized rental growth rates: (1) 0-percent rental growth rate; (2) 3-percent negative rental growth rate; and (3) 6-percent negative rental growth rate. As with single-family loan performance, these rates were applied in conjunction with the stochastic interest rate paths to generate the alternative cash flow vectors over which OAS valuations of GSE credit guarantees and mortgage assets are computed. The stochastic interest rate paths used for projecting single-family and multi-family loan performance are identical. The methodology for generating interest rates is described in the following section.[16]

Yield Curve and Interest Rate Simulation Methodology

This analysis implements the same interest rate methodology that the Office of Thrift Supervision (OTS) uses for valuing mortgage and mortgage servicing rights portfolios.[17] This model has a number of advantages over other models. Specifically:

1. It has already been vetted and published for use in a regulatory framework;
2. It straightforward to implement;
3. It relies on a relatively few set of parameters and the current yield curve;
4. It produces paths of both the one-month rate and the five-year rate.

The model takes as an input the current zero coupon yield curve and generates up to 200 simulated interest rate paths. Specifically, it was assumed that the initial one-month rate was 1.2% and that this rate rises linearly to 6% after thirty years. For each simulation the model actually produces two interest rate paths: a path for the one-month rate and a path for the five-year rate. The model assumes the one-month rate (f) and the five-year rate (r) evolve according to the following processes:

[16] The analysis applied relatively simple spread assumptions for the relationship between Treasury yields and mortgage rates. Wall Street financial valuations are more likely to be based on modeled relationships between Treasury yields and other rates and indexes. For example, see E. Belbase and D. Szakallas, "The Relationship Between the Yield Curve and Mortgage Current Coupon," Quantitative Perspectives, Andrew Davidson & Co., Inc, April 2001.

[17] The OTS publishes a complete description of the model on the model in their handbook, "The OTS Net Portfolio Value Model Manual" (Office of Thrift Supervision, Washington, D.C., pp 5.A-1-5.A-2.) The handbook is available online at: http://www.ots.treas.gov/CL.CFM?DON=48460&AN=3

Equation 1
One-Month and Five-Year Interest Rate Processes

$$\ln f_{n,t} = 0.135 \cdot \ln f^{*}_{n,t} + 0.865 \cdot \ln f_{n,t-1} + S_n$$

and

$$\ln r_{n,t} = 0.038 \cdot (\ln f_{n,t-1} + 0.156) + 0.962 \cdot \ln r_{n,t-1} + 0.23 \cdot U_{n,t} + W_{n,t}$$

where

$$f^{*}_{n,t} = 0.865 \cdot (\ln r_{n,t-1} - 0.156) - 0.370$$
$$S_n = 0.596 \cdot S_{n,t-1} - 0.365 \cdot S_{n,t-2} + U_{n,t}$$
$$U_{n,t} \sim \mathrm{N}(0,0.0367)$$
$$W_{n,t} = 0.495 \cdot W_{n,t-1} - 0.314 \cdot W_{n,t-2} + V_{n,t}$$
$$V_{n,t} \sim \mathrm{N}(0,0.297)$$
$$n = \textit{simulation path number}$$
$$t = \textit{simulation month}$$

To insure that zero coupon bonds priced through the simulation exactly match the initial zero coupon bond price, search for an adjustment factor for each time step in the simulation. This adjustment factor is added to each one-month spot rate in the simulation for that time step. Thus, in a 360-month model with 200 simulated interest rate paths, there would be 360 adjustment factors, one for each month of the simulation. Each adjustment factor A_t would be added to each of the 200 simulated one-month rates for month t.

Mathematically, these adjustment factors can be written as:

Equation 2
Adjustment Factors

$$\left(\frac{1}{N}\right)\sum_{n=1}^{N}\left[\prod_{t=1}^{T}(1+f_{n,t}+A_t)^{-1}\right]=(1+Z_T)^{-T}$$

where

$N = number\ of\ simulation\ paths$
$T = simulation\ month$
$Z_T = zero\ coupon\ yield\ \ for\ month\ T$
$f_{n,t} = simulated\ one\text{-}month\ rate\ in\ month\ t\ \ for\ \ path\ n$
$A_t = adjustment\ \ factor\ \ for\ month\ t$

The methodology used to find the adjustment factors was a secant-search algorithm. Upon completion, the interest rate simulation passes on two vectors for each simulation: a one-month rate vector and a five-year rate vector. The cash flow module uses these vectors to determine borrower behavior, and OAS module uses the one-month vector for discounting cash flows.

Option-Adjusted Spread (OAS) Methodology

The option-adjusted spread (OAS) is that spread over the risk-free rate that a mortgage pool yields, taking into account the embedded options in the mortgage. In the context of a Monte-Carlo simulation where there are multiple interest rate paths, the OAS is the spread above the risk-free that equates the average price of the mortgage with its market rate. Mathematically the OAS makes the following statement true:

Equation 3
OAS Calculation

$$Observed\ price\ of\ pool = \frac{1}{\mathrm{N}} \sum_{\mathrm{n=1}}^{\mathrm{N}} \left[\sum_{\mathrm{t=1}}^{\mathrm{T}} \frac{CF_{n,t}}{(1 + f_{n,t} + OAS)^{\mathrm{t}}} \right]$$

where

$f_{n,t} = simulated\ spot\ rate\ in\ month\ t\ of\ simulation\ n$
$CF_{n,t} = cash\ flow\ for\ month\ t\ in\ simulation\ n, given\ f_{n,t}$
$OAS = option\ adjusted\ spread$
$T = term\ of\ the\ mortgage$
$N = number\ of\ simulated\ interest\ rate\ paths$

Typically when one solves for an OAS one has a known market price for the pool of mortgages. Unfortunately, in this analysis, the "price" at which the mortgage was originated is not known with certainty. Since some assumption regarding price must be made to calculate the OAS, it was simply assumed that the mortgages were originally issued at par, and par value was assumed to be the initial price. This is a reasonable assumption for two reasons. First, most mortgages are, in fact, issued at par or at values close to it. Second, the purpose of this study is not to find the absolute level of OAS, but rather to find the relative effects that various parameters and policies have on OAS. If mortgages were issued at a discount to their par value, this would raise the absolute level of the OAS, but would not significantly change the relative effects on OAS.

Searching for the OAS is a relatively straightforward process using a secant search algorithm. The secant search algorithm is based on a Taylor series expansion of the pricing function. Specifically, let P(OAS) be the observed market price of the mortgage, or equivalently the price that the simulation will generate when the correct OAS value is used. Let P(OAS+X) be the price when some value of OAS other than the correct value is entered. Taylor's theorem states that the relationship between P(OAS) and P(OAS+X) will be given by (ignoring higher order terms.).

Equation 4
Taylor Series Expansion

$$\mathrm{P(OAS)} = \mathrm{P(OAS + X)} + \mathrm{X} \cdot \frac{\partial \mathrm{P(OAS + X)}}{\partial (\mathrm{OAS + X})}$$

One can use this relationship to solve for the OAS value. One must begin with a guess for OAS and determine a price given that OAS. If this price equals the observed price, i.e.

its P(OAS), then it is the correct OAS and can stop. If, however the guessed price differs from P(OAS), then one has the value for P(OAS+X). Rearranging the above equation allows one to estimate X:

Equation 5
Estimation of X

$$X \approx \frac{P(OAS) - P(OAS + X)}{\left(\frac{\partial P(OAS + X)}{\partial (OAS + X)} \right)}$$

The technique then simply adjusts the guess for OAS by X, and repeat the process until P(OAS+X) is within 1/100th of one cent of the observed price. Normally this process will converge to an answer with five or six iterations.[18]

Guarantee-Adjusted Spread (GAS) Analysis for Credit Guarantees

Traditional OAS analysis is used to determine the constant spread over the zero-coupon Treasury spot rate curve that equates the expected discounted present value of a mortgage to its current market price. The expectation is taken across a large number of randomly generated interest rate paths that satisfy standard arbitrage-free conditions and that are consistent with market expectations as embodied in the initial yield curve. In principle, the same methodology can be applied to any set of interest-rate dependent cash flows if one can identify a corresponding market price or valuation as a basis of comparison. For example, the OAS method has been used to provide fair-market valuation of mortgage servicing rights. Mortgage servicing rights are traded in the market, providing a benchmark market valuation against which OAS valuation can occur.[19]

The "guarantee-adjusted spread," or GAS, is defined as the constant spread above the zero-coupon Treasury spot rate curve that equates the expected discounted present value of the net revenues from credit guarantees to the initial equity investment or

[18] Relatively few iterations are needed when computing OAS values net-interest income investments. Much larger numbers of iterations were often required when computing GAS values for credit guarantees (see following section of the main text), particularly under adverse economic scenarios when rates of return were negative. In addition, a more extensive search for suitable starting values for the initial OAS was often required.

[19] When the market for mortgage servicing rights is illiquid, a suggested alternative is to look at inter-coupon spreads on TBA's ("to-be-announced" or generic mortgage securities traded in advance of specification of actual pools) to see how the bond market would price a similar stripped security. See C. Richard III and T.A. Rettinger, "Market for Mortgage Servicing Rights," presented at the MBA Accounting Conference, Dallas, TX, December 11-13, 2002. One shortcoming of this approach for the present analysis is that the level and timing of the costs of mortgage servicing may differ substantially from those associated with credit guarantees.

minimum capital requirement on off-balance sheet obligations. Although GSE credit guarantee portfolios are not traded in the market, the initial equity investment or capital requirement constitutes an upfront cost or "price" for an enterprise to engage in this activity. For example, the OFHEO minimum regulatory capital requirement of 45 bps on off-balance sheet guarantees sets the minimum up-front cost or equity investment of undertaking to provide credit guarantees on conforming loans. For simplicity, we assume that the initial equity investment is held as a corresponding share of each mortgage related security that is issued. Thus, like other security investors the GSE earns the pass-through rate on this share of the pool. However, the GSE also earns guarantee fees and covers all administrative expenses and default costs on the entire unpaid principal balance of the pool.[20]

The calculation of expected ROE values for new mortgage guarantees involves two key relationships: (1) computation of the GAS by solving for the constant spread above the zero-coupon Treasury yield curve that equates the expected value of net revenues on credit guarantees to the initial equity investment or capital requirement; and (2) application of the resulting risk-adjusted discount factors to compute expected ROE values across interest rate paths.

Net Income from Credit Guarantees

The cash flows resulting in net income on credit guarantees at time *t* for interest rate scenario (simulation path) *n* are given by:

Equation 6
Credit Guarantee Cash Flows

$$
\begin{aligned}
CF_{n,t} &= payment_{n,t} - passthrough_{n,t} \cdot (1-k) - servicing_{n,t} - admin_{n,t} - loss_{n,t} \\
&= payment_{n,t} - (payment_{n,t} - gfee_{n,t} - servicing_{n,t}) \cdot (1-k) - servicing_{n,t} - admin_{n,t} - loss_{n,t} \\
&= gfee_{n,t} - (payment_{n,t} - gfee_{n,t} - servicing_{n,t}) \cdot k - admin_{n,t} - loss_{n,t}
\end{aligned}
$$

Payments are received from borrowers and a portion must be passed through to the security investors. The passthrough obligation is reduced by the GSE's own equity investment in the security. In addition, the GSE pays for loan servicing, administrative expenses, and net losses on non-performing loans not covered by third-party credit enhancements or from the sale of the security property. The cash flow equation has been

[20] Because the GSEs effectively conduct two lines of business, this raises an interesting issue of capital deployment versus capital allocation. While the GSEs are required to meet overall regulatory capital requirements of 45 bps for off-balance sheet guarantees and 250 bps for retained mortgages, whether they actually allocate 45 bps of capital to their guarantee business is another question. Some of the 45 bps of capital associated with the guarantees may be deployed elsewhere. For example, their actual loss reserves may be a better proxy for the capital allocated to running the guarantee business, with the "excess" capital being "loaned" to the portfolio business (or the liquidity portfolio). Fannie Mae's financial statements make some comments pertaining to this distinction. In practice, the GSEs probably compute their guarantee fees, loss reserves, and optimal capital levels simultaneously.

rewritten to illustrate more clearly how the main source of GSE revenue is guarantee fees and GSE costs comprise capital costs, administrative expenses, and credit losses.

Solving for GAS Values

Over a large number, N, of random interest rate paths the final GAS value satisfies the following condition:

Equation 7
Solving for GAS Using Zero-Coupon Spot Rates

$$\mathrm{k} \cdot UPB(0) = \frac{1}{N} \sum_{n=1}^{N} \sum_{t=1}^{T} \frac{CF_{n,t}}{(1 + z_{n,t} + \mathrm{GAS})^{t}}$$

where $UPB(0)$ is the original loan balance and $z_{n,t}$ is the zero-coupon spot rate for maturity t on path n. Alternatively, one can solve for the GAS in terms using zero-coupon 1-month forward rates as follows:

Equation 8
Solving for GAS Using Zero-Coupon Forward Rates

$$\mathrm{k} \cdot UPB(0) = \frac{1}{N} \sum_{n=1}^{N} \sum_{t=1}^{T} \frac{CF_{n,t}}{\prod_{s=1}^{t} (1 + f_{n,s} + \mathrm{GAS})}$$

where $f_{n,t}$ is the 1-month forward rate for month t on interest rate path n.

OAS Valuation of GSE Loans

OAS values were computed for GSE loans stratified by relative income, LTV, and underserved area classifications. Comparison of OAS values for subgroups of GSE mortgage loans was used to assess the relative interest-rate risk of these assets associated with their embedded prepayment options. This does not constitute a full valuation of GSE net-interest income investments analogous to that undertaken for GSE credit guarantees. More complete valuation of GSE net-interest income investments would require detailed information on GSE funding and hedging strategies. These funding and hedging strategies may be very complex in their use of derivatives and may change significantly over time at the discretion of the GSE in response to evolving market conditions. Actual GSE funding and hedging decisions are "strategic" in the sense that

they apply to the entire portfolio of retained loans and mortgage-related securities, and are not necessarily matched directly to the most recent loan purchases.

Insofar as the housing goals are defined with respect to annual loan purchases, this analysis has been limited to comparisons of the risk characteristics of new loan purchases. In the case of credit guarantees, there are only two relatively simple sources of funding: (1) securitization and creation of a passthrough obligation; and (2) the GSE's own equity capital investment. The contractual terms of a passthrough security are determined at issuance, and although the ultimate value or profitability of the associated loan guarantees will depend on future interest rates and housing values, aside from adjusting loss reserves or risk-based capital levels, there is little need or opportunity for "dynamic" funding or hedging responses of the sort that characterize asset-liability management of a retained mortgage portfolio.

Nevertheless, new loan purchases do represent a potential increase in exposure to interest rate risk. The relevant question is whether targeted loan purchases are qualitatively or quantitatively different in this regard. The results indicate that some targeted loan purchases are actually less risky, and potentially more valuable, to a GSE due to their relatively lower propensity to prepay. These differences were summarized by computing OAS values for the same loan classifications used to compare the profitability of GSE credit guarantees. The OAS values for lower-income loans are consistently lower than those of other loan groups, indicating that these loans are less sensitive to interest rates and more valuable relative to risk-free investments.

Profitability Calculations

Expected ROE values were computed across all the random interest rate scenarios using the overall GAS value to determine the appropriate risk-adjusted discount factors under each interest rate path. Separate expected ROE values are computed for each loan classification based on property types, relative income classifications, LTV categories, and whether the loans are secured by properties located in underserved areas. Overall weighted average ROE values are computed by rescaling the original loan balances in each category to match the purchase assumptions. The entire process was repeated for each of the three economic scenarios.

Summary of Key Findings

Additional targeted lending under the new housing goals is projected to have a negligible impact on the profitability of GSE credit guarantees and market valuations of GSE mortgage assets. In large measure, this is due to the fact that the baseline scenarios already include significant volumes of low-income loans and loans in underserved areas required under the goals. The increased lending to low-income borrowers and borrowers in underserved areas entails essentially the same highly profitable activity in which the GSE have been engaged over several years. This result holds over the widely varying economic scenarios for single-family house price appreciation and multi-family rental rates applied in the financial analysis. Although the economic environment is projected

to have a significant impact on the value of GSE credit guarantees, additional targeted lending under the housing goals is projected to perform in a manner similar to baseline loan purchases across all scenarios, and represents no additional risk to GSE profitability.

Valuation of GSE Credit Guarantees

Tables 6.8 and 6.9 summarize the results of financial simulations undertaken to compute the expected return-on-equity (ROE) of GSE credit guarantees under a range of future economic scenarios. Table 6.8 reports the results for Fannie Mae loan and Table 6.9 reports the results for Freddie Mac. The tables report expected ROE values for credit guarantees on loans secured by different types of single-family and multi-family properties: single-family owner occupied properties (SFO), single-family 1-4 unit owner occupied properties (SF14), single-family 2-4 unit rental properties (SF24), and multi-family (5 or more unit) rental properties (MF). Results are generated under three alternative economic scenarios for appreciation rates of single-family house prices: (1) 4-percent positive appreciation; (2) 2-percent positive appreciation; and (3) 2-percent negative appreciation; and three corresponding scenarios for changes in multi-family unit rental rates: (1) 0-percent; (2) 3-percent negative; and (3) 6-percent negative growth rates.

Two sets of results are shown in each summary table: (1) results based on unadjusted loan performance models; and (2) results based on adjusted loan performance models. The first set of results is based on application of published OFHEO loan performance models estimated using Fannie Mae and Freddie Mac historical loan performance data from the 1980s and 1990s. The second set of results is based on the same underlying models, but where the conditional default rates are increased and REO proceeds are decreased for low-income loans and loans to borrowers in underserved areas. These adjustments are intended to simulate a hypothetical degradation in loan performance in the event that the GSEs need to adopt less restrictive underwriting standards in order to comply with the housing goals regulations.

Tables 6.8 and 6.9 report expected ROE values on an after-tax basis. Expected ROE values under Scenario 1 are approximately 31 percent for loans secured by single-family owner-occupied (SFO) properties. These rates are generally consistent with the overall ROEs reported by the GSEs in their annual financial disclosures, and indicate that the OFHEO models produce results consistent with the recent economic performance of the GSEs under similar economic circumstances. Projected ROE values for loans secured by multifamily properties, which are not reported separately in GSE financial disclosures, are slightly higher—40 percent for Fannie Mae and 36 percent for Freddie Mac. While there was no way to independently verify whether these profit rates are representative of actual GSE financial performance on multi-family loans, they are consistent with somewhat higher guarantee fees, extensive loss-sharing arrangements, and the generally conservative approach to underwriting applied to this component of their guarantee businesses.[21]

[21] In the case of single-family loans the analysis applied a schedule of guarantee fees by original LTV that is generally consistent with the weighted-average guarantee fees and LTV distributions reported in the GSE

Lifetime Cumulative Default Rates

Tables 6.10 and 6.11 report the average lifetime cumulative default rates corresponding to each of the loan portfolios and economic scenarios underlying the results in Tables 6.8 and 6.9. The three economic scenarios produce substantially different loan performance outcomes, and these are magnified under the results for the adjusted default rate models in the bottom panel of each table. Although single-family default rates on additional targeted lending are significantly greater than default rates on baseline purchases under the most stressful scenarios, this does not translate directly into the same relative differences in ROE values because of higher guarantee fees and higher mortgage insurance coverage ratios on high LTV loans.

OAS Valuation of GSE Mortgage Assets

The analysis did not attempt to value GSE net-interest income investments (defined as purchased mortgage loans held in portfolio, net of credit guarantees). The relative risk of these investments ultimately depends on the interaction of loan performance with the dynamic funding and hedging strategies of the enterprises, of which there is limited public disclosure. However, it is possible to address the question of whether additional targeted lending requires acquisition of loans with substantially lower value as "mortgage assets." Starting from a buy-and-hold-to-maturity perspective and assuming all loans are purchased at par, we computed option-adjusted spread (OAS) values across the same loan stratifications used in comparing ROE values on GSE credit guarantees. The resulting OAS values were used to assess the relative values of different mortgage categories in relation to risk-free zero-coupon bonds.

Tables 6.12 and 6.13 report the average OAS values based on the same loan stratifications. Higher OAS values indicated relatively higher valuations. The primary source of differences in the OAS valuations is the interest-rate sensitivity of the underlying mortgage assets—either they are less likely to prepay during declining rate environments, or they are more likely to prepay during increasing rate environments, making them less sensitive overall to interest rate volatility. The results indicate, in general, slightly lower OAS values for additional targeted lending for single-family owner-occupied (SFO) and multi-family (MF) mortgages, and slightly higher OAS values for single-family 1-4 owner-occupied (SF14) and single-family 2-4 unit rental (SF24) properties. Additional targeted lending has virtually no impact—generally less than 1 basis point—on the overall average OAS values for total lending on each property type. This indicates that additional targeted lending under the proposed housing goals is not an additional source of financial risk for GSE net-interest income investments.

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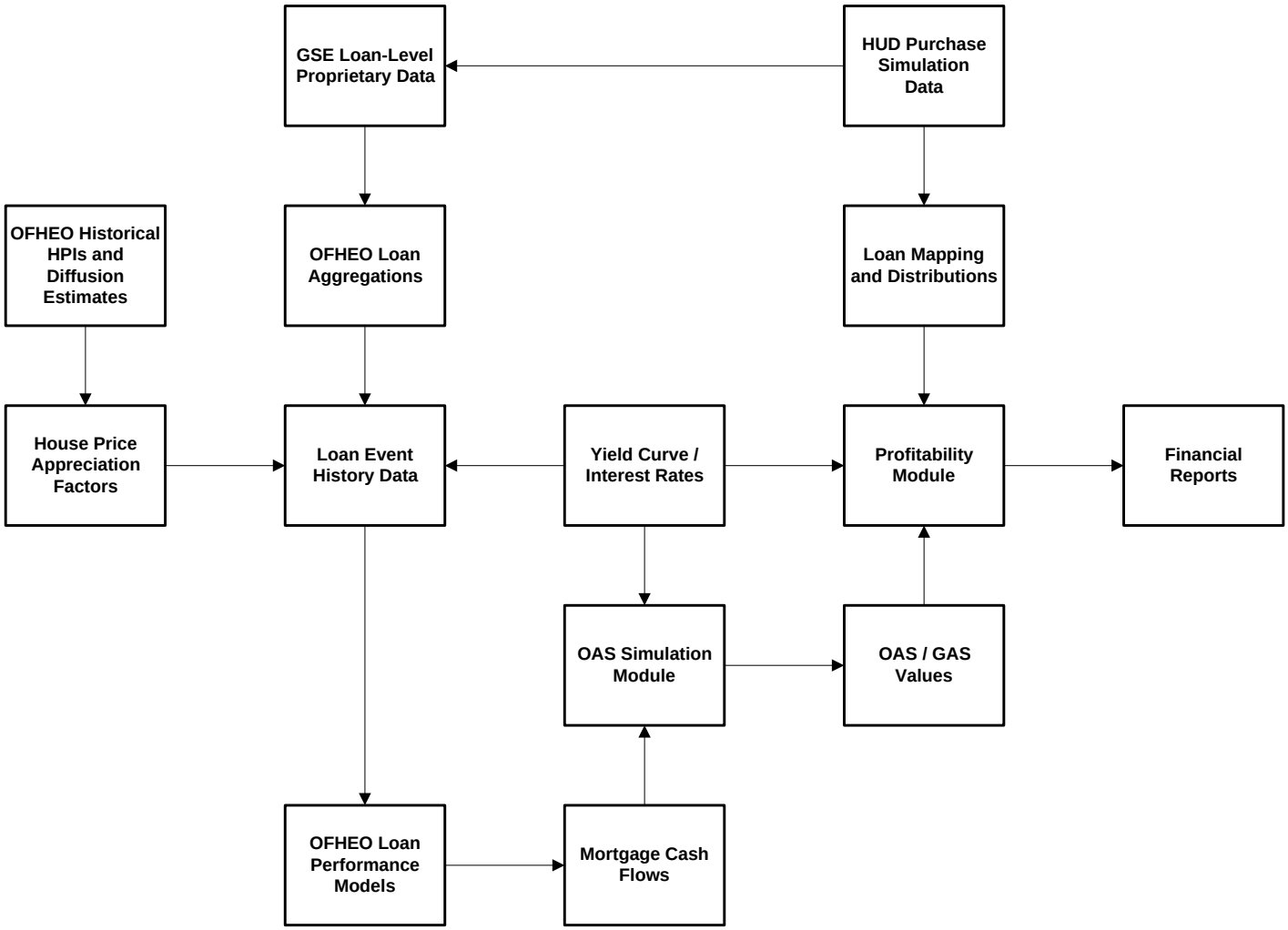
financial disclosures. For multi-family loans we experimented with different values for the guarantee fee and settled on 30 bps as a value that produces reasonable values for ROE under the most favorable economic scenario. In any event, the same value is applied to all loans across all scenarios so that relative differences in financial performance do not depend on the guarantee fee assumed.

Implications for Additional Targeted Lending

The primary objective of the financial analysis was to assess whether the GSEs will earn reasonable rates of return on additional targeted lending under the changes to the housing goals. The GSEs have earned high returns on both their baseline and targeted purchases. The basic analysis applied mortgage default and prepayment models developed from GSE historical loan performance data covering a period of nearly 20 years. To account for potential structural changes in mortgage risk associated with more aggressive underwriting in pursuit of loans that qualify under the goals, the analysis also looked at outcomes based on adjusted models in which mortgage default rates are increased and REO sales proceeds are decreased on low-income loans and loans in underserved areas. Results based on the adjusted loan performance models are generally consistent with those based on the unadjusted models. The analysis concludes that the GSEs will not experience any significant deterioration in the profitability of their credit guarantee business under the new housing goals.

These findings parallel the results of previous financial analyses of changes to the housing goals in 1995 and 2000. One significant difference between the current and previous analyses is the increased level of detail with which this analysis was able to undertake valuations of GSE credit guarantees. Thus, the methodology developed for this analysis has potential application to the design, evaluation, and pricing of targeting lending or other specialized portfolios that extend beyond the scope of this project.

Exhibit 1
Profitability Analysis Model Components Flow Chart



Steps Undertaken to Project GSE Loan Performance

1. Read the loan-level GSE data. For the large single-family loan portfolios apply random sampling to reduce the data storage requirements.

2. Create classification variables corresponding to those used by the GSEs when submitting data to OFHEO for input to the OFHEO RBC model.

3. Pool (aggregate) the loan-level data into loan groupings matching those used by OFHEO. Aggregating the data significantly reduces the data storage requirements, but still preserves all the detail needed to create the explanatory variables in the OFHEO default/prepay models. In addition, we maintain stratification of the data over the relative income, LTV, property type, and underserved area classifications.

4. Create the explanatory variables.

    a. Link with historical interest rate data and use average mortgage rates to assign origination rates (missing in the available GSE loan-level data). This produces some variability in origination rates since loans were originated throughout the calendar year.

    b. For single-family loans, expand the data to 120 quarterly observations for each loan covering potential mortgage lifetimes of 360 months. The OFHEO single-family loan performance models are for quarterly conditional probabilities of default and prepayment. The quarterly probabilities were subsequently converted to monthly factors for use in projecting mortgage cash flows. For multi-family loans, expand the data to 360 monthly observations covering potential mortgage lifetimes 360 months. The OFHEO multi-family loan performance models are for annualized conditional probabilities of default and prepayment, but depend on monthly economic data for creating the explanatory variables. The annualized probabilities were subsequently converted to monthly rates for use in projecting mortgage cash flows.

    c. Link with simulated interest rate data from yield curve and interest rate simulation module. The monthly rate paths are converted to quarterly averages for the purpose of creating interest rate variables in the OFHEO single-family loan performance models. For the OFHEO multi-family loan performance models monthly interest rate information was used to update a prepayment incentive factor. The procedures applied correspond to how the explanatory variables were created by OFHEO for estimating the models.

    d. Update the values of explanatory variables that change over the loan life, such as loan age, interest rate spread, yield curve slope, burnout, and the probability of negative equity for single-family loans; and loan age, debt-service coverage ratios, rental growth rates, rental vacancy rates, and prepayment incentive factor for multi-family loans.

        i. For single-family loans, the probability of negative equity is based on an assumed constant rate of house price appreciation, OFHEO HPI volatility parameters, and loan amortization.
        ii. For multifamily loans, the rental growth rate is based on assumed constant rates that parallel those assumed for single-family house prices.

5. Apply the OFHEO model parameters to compute conditional probabilities of default and prepayment.

6. For single-family loans, expand the quarterly loan performance outcomes to monthly data for purpose of generating monthly cash flows. This also follows the methodology of the OFHEO RBC model. Quarterly default and prepayment probabilities are converted to monthly probabilities.

7. Create loan amortization schedules and compute monthly cash flows including:

interest
scheduled principal
unscheduled (prepaid) principal
defaulted principal
net loss on defaulting loans
guarantee fee income

a. Apply the loss severity assumptions from the OFHEO RBC model to determine net losses on defaulting loans.

b. Compute cumulative default and prepayment rates at each month.

8. Save the results of the loan performance analysis to data files. These files can be used to report differences in loan performance by different loan characteristics or goal classifications. We collapse the detailed cash flows to reduce the file size, while still maintaining the detail needed to compute results specific to loan product and property types and relative income, LTV, and underserved area classifications.

9. Compute class-specific OAS and GAS values. The OAS module is executed twice for each classification group, once to determine the OAS on mortgage assets (net interest income investment component), and again to compute the GAS on net income from credit guarantees.

10. Compute expected ROE values for credit guarantees. The GAS values are combined with the zero-coupon Treasury yield curve to compute risk-adjusted discount factors for valuing expected mortgage cash flows.

Simulation Model Inputs and Assumptions

Item	Values	Source / Comments
Loan-level data.	GSE proprietary loan-level data. Annual mortgage purchases for calendar year 2001.	HUD data.
Data aggregation and stratification.	Data aggregations based on OFHEO regulatory reporting requirements with additional stratifications to preserve detail on HUD targeted lending classifications.	10-percent random sampling of single-family loan records. 100-percent sample of multi-family loan records.
Single-family and multi-family loan default and prepayment models.	Published models from OFHEO risk-based capital regulations for GSEs.	OFHEO applies the same models in computing risk-based capital requirements on current GSE mortgage portfolios. Single-family model for quarterly conditional default and prepayment probabilities based on multinomial logit specification. Multi-family model for monthly conditional default probabilities and deterministic rule for prepayment.
Model adjustments for targeted lending.	Adjustments are applied to default rates on low-income loans and loans secured by properties in underserved areas (as defined by HUD classifications). Default rates are multiplied by 1.5 if classified as low-income. Default rates are multiplied by 1.5 if loan is classified as a loan in an underserved area. REO proceeds are multiplied by 0.8 if loan is classified as low-income. REO proceeds are multiplied by 0.8 if loan is a loan in an underserved area.	OFHEO applies a different set of adjustments to meet statutory requirements related to their historical benchmark credit loss experience. Multiples are applied to monthly default factors computed from quarterly conditional probability models. Adjustments are cumulative. If loan is both low-income and in an underserved area, both adjustment factors are applied and conditional default rate is increased by factor of 2.25. Adjustments are cumulative. If loan is both low-income and in an underserved area, both adjustment factors are applied and REO proceeds are scaled by factor of 0.64.
House price scenarios.	3 scenarios for annualized house price appreciation rates: (1) 4-percent positive appreciation. (2) 2-percent positive appreciation. (3) 2-percent negative appreciation.	The OFHEO models include a variable for the probability a borrower is in a negative equity position at any time period in the life of the loan. House price appreciation factors are applied in combination with OFHEO house price diffusion volatility assumptions to update this variable.
Interest rates scenarios.	Yield curve simulations for zero-coupon spot rates are based on published OTS models. Other rates and yields are derived based on observed historical average spreads to Treasury rates.	The OFHEO models include variables for (1) the current value of the relative spread between the mortgage note rate and the current market average fixed-rate mortgage rate; (2) the slope of the Treasury yield curve; and (3) a "burnout" factor related to the recent history of mortgage rates and refinance

Simulation Model Inputs and Assumptions

Item	Values	Source / Comments
		opportunities.
Spread of 10-year to 5-year rate.	0.35	Historical average spread of 10-year CMT to 5-year CMT.
Spread of 1-year to 1-month rate.	0.32	Historical average spread of 1-year CMT and 3-month CMT.
Original mortgage note rates.		The GSE loan-level proprietary data do not include information on mortgage coupon rates. Current average market rates were used to assign original note rates for loans originated at different months with the year.
ARM margin to 1-year CMT.	2.75	Standard ARM margin on GSE loans.
OAS valuation.	OAS valuation models are based on published OTS models, modified for application to valuation of credit guarantees.	Mortgage cash flows are generated under each interest rate simulation path and house price scenario combination.
OAS valuation of credit guarantees.	Initial "price" of GSE credit guarantee is defined as minimum regulatory capital requirement equal to 45 basis points of original loan balance.	Net income is a function of guarantee fee income, administrative expenses, servicing costs, and default costs. GSE also earns interest on share of loan balance held as equity.
OAS valuation of mortgage assets.	Initial "price" of GSE mortgage asset is original loan balance, corresponding to par pricing.	Net income is a function of mortgage interest and principal payments.
Guarantee fees.	Following schedule of LTV-specific guarantee fees was applied: 16 bps – LTV (0, 60] 18 bps – LTV (60, 80] 22 bps – LTV (80, 90] 24 bps – LTV (90+]	Based on reported LTV distributions in recent GSE financial disclosures this schedule of rates implies weighted average fee of 18.8 for Fannie Mae and 18.5 for Freddie Mac.
Servicing fees.	25 bps.	Minimum servicing fee on GSE loans.
Administrative fees.	7 bps.	
Corporate tax rate.	35 percent.	
Single-family loss severity.		OFHEO assumptions.
Months delinquent prior to foreclosure.	4 months.	
Months to foreclosure.	13 months.	
Foreclosure costs.	0.037	Percent of defaulting UPB.
REO expenses.	0.163	Percent of defaulting UPB.
REO proceeds recovery rate.	0.61	Percent of projected average property value based on sequence of appreciation factors for given scenario. For example, Recovery rate on defaulting UPB is 61 percent if "current" LTV is 100 percent, 74 percent if current LTV is 80 percent, and 100 percent if current LTV is 61 percent.
Mortgage insurance coverage ratios.	0.00 – LTV (0, 80] 0.12 – LTV (80, 85] 0.25 – LTV (85, 90]	MI coverage initially based on original LTV. Current LTV for removal of MI coverage is based on sequence of appreciation factors since loan origination.

Simulation Model Inputs and Assumptions

Item	Values	Source / Comments
	0.30 – LTV (90, 95] 0.35 – LTV (95+] 0.00 – current LTV (0, 78]	This varies under different house price scenarios. Assume MI claims paid on all defaulting loan balances and GSE retains title to REO property.
Additional assumptions for multi-family loans		
LTV	.80	No LTV information in GSE loan-level proprietary data.
DCR	1.30	No DCR information in GSE loan-level proprietary data.
Operating expense rate.	0.472	OFHEO assumption.
MF ARM margin.	3.00	
MF FRM spread to SF at origination.	0.50	
MF guarantee fee.	30 bps.	
Rental growth rates for multi-family loans.	3 scenarios for annualized rental growth rates: (1) 0-percent. (2) 3-percent negative. (3) 6-percent negative.	These are applied in conjunction with corresponding single-family house price scenarios.
MF loss severity. MF months to foreclosure. MF REO expense rate. MF REO recovery rate.	 18 0.1333 0.5888	OFHEO assumptions.
Loss sharing on MF loans.	0 percent of loss on cumulative losses less than or equal to 5 percent of original loan balance. 75 percent of loss on cumulative losses greater than 5 percent or less than or equal to 20 percent of original loan balance. 90 percent of loss on cumulative losses greater than 20 percent of original loan balance.	Fannie Mae DUS program feature that is applied to all Fannie Mae loans.

Detailed Tabulations for Single-Family Loans

GSE Name	Output Value	Portfolio / Asset	Default / Prepay Model	Default Rates Adjusted for Targeted Lending	House Price Scenario	Table Name (Link to Excel Workbook)
FNMA	ROE	SF Guarantees	OFHEO	No	1 2 3	FNMA.SF.ROE.OFHEO.UDR.xls
FNMA	ROE	SF Guarantees	OFHEO	Yes	1 2 3	FNMA.SF.ROE.OFHEO.ADR.xls
FHLMC	ROE	SF Guarantees	OFHEO	No	1 2 3	FHLMC.SF.ROE.OFHEO.UDR.xls
FHLMC	ROE	SF Guarantees	OFHEO	Yes	1 2 3	FHLMC.SF.ROE.OFHEO.ADR.xls
FNMA	Cumulative Default Rate	SF Loans	OFHEO	No	1 2 3	FNMA.SF.DEF.OFHEO.UDR.xls
FNMA	Cumulative Default Rate	SF Loans	OFHEO	Yes	1 2 3	FNMA.SF.DEF.OFHEO.ADR.xls
FHLMC	Cumulative Default Rate	SF Loans	OFHEO	No	1 2 3	FHLMC.SF.DEF.OFHEO.UDR.xls
FHLMC	Cumulative Default Rate	SF Loans	OFHEO	Yes	1 2 3	FHLMC.SF.DEF.OFHEO.ADR.xls
FNMA	OAS	SF Loans	OFHEO	No	1 2 3	FNMA.SF.OAS.OFHEO.UDR.xls
FNMA	OAS	SF Loans	OFHEO	Yes	1 2 3	FNMA.SF.OAS.OFHEO.ADR.xls
FHLMC	OAS	SF Loans	OFHEO	No	1 2 3	FHLMC.SF.OAS.OFHEO.UDR.xls
FHLMC	OAS	SF Loans	OFHEO	Yes	1 2 3	FHLMC.SF.OAS.OFHEO.ADR.xls
FNMA	Original Loan Balances	SF Loans	--	--	--	FNMA.SF.BAL.xls
FHLMC	Original Loan Balances	SF Loans	--	--	--	FHLMC.SF.BAL.xls

Detailed Tabulations for Multi-Family Loans

GSE Name	Output Value	Portfolio / Asset	Default / Prepay Model	Default Rates Adjusted for Targeted Lending	Economic Scenario	Table Name (Link to Excel Workbook)
FNMA	ROE	MF Guarantees	OFHEO	No	1 2 3	FNMA.MF.ROE.OFHEO.UDR.xls
FNMA	ROE	MF Guarantees	OFHEO	Yes	1 2 3	FNMA.MF.ROE.OFHEO.ADR.xls
FHLMC	ROE	MF Guarantees	OFHEO	No	1 2 3	FHLMC.MF.ROE.OFHEO.UDR.xls
FHLMC	ROE	MF Guarantees	OFHEO	Yes	1 2 3	FHLMC.MF.ROE.OFHEO.ADR.xls
FNMA	Cumulative Default Rate	MF Loans	OFHEO	No	1 2 3	FNMA.MF.DEF.OFHEO.UDR.xls
FNMA	Cumulative Default Rate	MF Loans	OFHEO	Yes	1 2 3	FNMA.MF.DEF.OFHEO.ADR.xls
FHLMC	Cumulative Default Rate	MF Loans	OFHEO	No	1 2 3	FHLMC.MF.DEF.OFHEO.UDR.xls
FHLMC	Cumulative Default Rate	MF Loans	OFHEO	Yes	1 2 3	FHLMC.MF.DEF.OFHEO.ADR.xls
FNMA	OAS	MF Loans	OFHEO	No	1 2 3	FNMA.MF.OAS.OFHEO.UDR.xls
FNMA	OAS	MF Loans	OFHEO	Yes	1 2 3	FNMA.MF.OAS.OFHEO.ADR.xls
FHLMC	OAS	MF Loans	OFHEO	No	1 2 3	FHLMC.MF.OAS.OFHEO.UDR.xls
FHLMC	OAS	MF Loans	OFHEO	Yes	1 2 3	FHLMC.MF.OAS.OFHEO.ADR.xls
FNMA	Original Loan Balances	MF Loans	--	--	--	FNMA.MF.BAL.xls
FHLMC	Original Loan Balances	MF Loans	--	--	--	FHLMC.MF.BAL.xls

Appendix B to Chapter VI

OFHEO Default and Prepayment Models

OFHEO's final risk-based capital rule for the Enterprises applies three versions of loan-level models for single-family default and prepayment probabilities: (1) a model for 30-year fixed-rate mortgages (FRMs); (2) a model for adjustable-rate mortgage (ARMs); and (3) a model for other (OTHER) FRM loans, including balloon loans, 15-year FRMs, 20-year FRMs, and government loans.[1] All of the models estimate quarterly conditional joint probabilities of default and prepayment conditional on the age of the loan and the other explanatory variables.[2] All of the explanatory variables (discussed below) are coded as categorical variables. The models for ARMs and other loans are modified versions of the baseline 30-year FRM model. For example, the ARM model is estimated on a pooled sample of 30-year FRM and ARM loans, but includes additional variables specific to the performance of ARM loans relative to that of 30-year FRM loans. The OTHER model is estimated on a pooled sample of 30-year FRM loans and the other loan types, and includes variables to measure their performance relative to 30-year FRM loans.

The models were all estimated on pooled samples of millions of Enterprise loans purchased between 1975 and 1999. OFHEO combined loan-level information from both Enterprises to develop its own data files for statistical analysis. Standardized or "normalized" data files were constructed to assure similar content and structure across Enterprises. OFHEO used the data to reconstruct "event histories" for the period-by-period performance of individual loans from the date of origination to the point where the loan terminated or the end of the sample period was reached.

Conditional rates of default and prepayment vary depending on a variety of factors, both random and systematic, some of which are fixed at origination and others that vary over time. Characteristics of loans and borrowers at origination can affect the level and timing of mortgage default and prepayment throughout the life of the loan. For example, conditional default and prepayment rates exhibit characteristic age-profiles that increase during the first years following origination, peak sometime between the fourth and seventh years, and decline gradually over the remaining years.[3] Default and prepayment rates also vary systematically in response to economic circumstances and other factors over time, such as changes in house prices and interest rates that affect the value to the borrower of embedded options.

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[1] 12 CFR Part 1750 Office of Federal Housing Enterprise Oversight; Risk-Based Capital, Federal Register, Vol. 66, No. 178, pp. 47730-47875, Thursday, September 13, 2001; and Federal Register, Vol. 67, No. 177, pp. 57760-577767, Thursday, September 12, 2002.

[2] The quarterly probabilities are converted to monthly default and prepayment probabilities for projecting mortgage cash flows in the RBC stress test.

[3] See the discussion in Schwartz, E. S. and W. N. Torous, "Prepayment And The Valuation Of Mortgage-Backed Securities," *The Journal of Finance* 44(2):375-392, 1989.

As outlined above, mortgage default and prepayment events result from a borrower's decision to terminate the mortgage, either by prepaying or defaulting, resulting in an observed last-paid-installment, after which no further payments are forthcoming. Thus, for loans outstanding at the end of each time period, three mutually exclusive outcomes are possible in the model: (1) the borrower defaults; (2) the borrower prepays the loan in full; or (3) the borrower makes the scheduled loan payment, and the loan remains active and part of the event history sample for the next time period. For the purposes of statistical analysis, each of these outcomes is interpreted as an "event." This approach implies that each loan contributes potentially many observations to the event history sample, depending on how long it remains active before experiencing one of the terminal events or reaching the end of the sample period.

OFHEO estimated multinomial logit models for quarterly conditional probabilities of default and prepayment.[4] Several empirical studies have applied some form of the logit or similar qualitative response models to analyze mortgage prepayment and default behavior.[5] OFHEO estimated the models using loan-level data. However, the loan-level models were specified using categorical explanatory variables so that the same models can be applied to aggregate loan groupings without loss of precision as long as the aggregated data were stratified using the same variable categories.

OFHEO Model Specifications

The OFHEO model specifications and qualitative summaries of the variable effects are given in Table B.1. Detailed model estimates are reported in OFHEO final rule. There are some differences in the models reported in OFHEO's proposed RBC rule published in April 1999 (discussed in HUD's Economic Analysis for the 2000-2003 goals), and the model estimates reported in OFHEO's final RBC rule published in September 2001. The most significant differences are discussed below and noted in Table B.1. The ordering of the variables in Table B.1 and in the following discussion follows that of OFHEO final RBC rule as published in the Federal Register.

As mentioned above, all of the explanatory variables were coded as categorical variables. Assigning the various explanatory variable outcomes to categories allows one to estimate effects that may be non-linear without having to experiment with many different functional forms. In addition, because each categorical explanatory variable has minimum and

[4] The quarterly default and prepayment probabilities were converted to monthly factors for input to the monthly cash flow calculations required for application in the RBC stress test.

[5] Examples of previous applications of the logit model are T.S. Campbell and J.K. Dietrich, "The Determinants of Default on Insured Conventional Residential Mortgage Loans," *Journal of Finance*, 38:1569-1581, 1983; P. Zorn and M. Lea, "Adjustable Rate Mortgage, Fluctuations In The Economic Environment And Lender Portfolio Change," *AREUEA Journal* 14:432-447, 1986; and D. Cunningham and C. Capone, "The Relative Termination Experience Of Adjustable To Fixed-Rate Mortgages," *The Journal of Finance* 45(5):1687-1703, 1990.

maximum categories (determined through observation of the historical data), the impacts of particular variables on rates of default or prepayment projected from the model are constrained to be within previous historical experience. This helps to avoid unreasonable extrapolations when projecting mortgage performance under stress test conditions. Another advantage of using categorical outcomes for the explanatory variables is that it anticipated the need to apply the models to aggregated loan groupings in the OFHEO stress test, based on quarterly data submissions by the Enterprises.

Mortgage Age

The existence of other demographic and economic processes that may "trigger" mortgage default, and the inability to measure the diffusion of house prices and the distribution of borrower equity precisely at the loan level, imply the need to account directly for age-specific differences in conditional rates of default and prepayment. The OFHEO models for the final RBC rule utilize a set of dummy (0/1) indicators for specific age categories, where loan age is measured in quarters.

The OFHEO model estimates indicate that the default probability increases with mortgage age up to 24 quarters (6 years) and declines thereafter. The prepayment probability increases and peaks first in quarters 9-12, declines in quarters 13-20 increases and peaks again in quarters 21-24, then declines thereafter.

Original LTV

The LTV ratio serves as an indicator of the income and net worth of the borrower at mortgage origination, and directly determines the initial equity position of the borrower. To the extent that income and wealth are negatively correlated with original LTV, high LTV borrowers will have fewer economic resources to finance the transactions costs of prepayment or endure spells of unemployment or other trigger events that might otherwise cause them to exercise the default option in a sub-optimal manner. Finally, high LTV borrowers have already demonstrated a willingness to "leverage" the financing of the home purchase, which may portend a greater sophistication or "ruthlessness" in the exercise of the default option. Thus, one would expect higher rates of default and lower rates of prepayment as LTV increases. The LTV categories adopted by OFHEO are similar to those used by the Enterprises in their annual reports and information statements.

In the OFHEO model the default probability increases with LTV up to 70-75 LTV category, then declines for 75-80 and 80-90 categories. The default probability rises again for the above 90 LTV category, but only to about the level of the 75-80 category. The prepayment probability is highest for the above 90 LTV category and then for the below 60 LTV category, and lower for all other LTV categories.

The LTV estimates reported by OFHEO in their final RBC rule depart somewhat from the patterns reported in earlier OFHEO research based on Enterprise data and from other results in the literature. For example, OFHEO model estimates do not indicate that the highest LTV

loans have the highest tendencies to default. All other things the same, loans in the 70-75 LTV category have the highest probability of default. While other research has found this category to have slightly higher default risk than adjacent categories, we know of no other study that reports higher default rates for this category than for above 90 LTV loans. Previous estimates reported by OFHEO in their 1999 proposed RBC rule and in other OFHEO research based on the same Enterprise data, indicate that above 90 LTV loans have the highest default rates.[6] The main differences between the earlier studies and the models used for the final RBC rule are: (1) OFHEO added 6 additional years of data (1994-1999 originations), encompassing a period of very low default rates overall; and (2) OFHEO switched from using a quadratic mortgage age specification for default and prepayment to using the categorical age variables described above.

Probability of Negative Equity

The put option has value to the borrower when the property is worth less than the outstanding balance on the mortgage. In this case the borrower is in a negative equity position. The equity position of the borrower is determined by the difference between the market value of the property securing the loan and the unpaid mortgage balance. Ideally, periodic observations on the values of individual properties would be used to update individual house values and borrower equity at the same frequency (monthly) at which the decision to prepay or default can be exercised. The lack of continuous updating of individual housing values implies that it is not possible to compute updated values of borrower equity for individual borrowers with sufficient accuracy for this measure to be used directly at the loan level. It remains possible, however, to characterize the equity positions of individual borrowers in terms of *ex ante* probabilities of negative equity. The probability of negative equity is a function of the current loan balance and the likelihood of individual house price outcomes that lie below this value. OFHEO projects distributions of individual housing values relative to the value at mortgage origination by applying estimates of house price drift and volatility based on the OFHEO House Price Index (HPI).[7]

The required estimates of house price drift and volatility are direct by-products of the estimation of the OFHEO HPI. The OFHEO HPI is based on a modified version of the weighted-repeat-sales (WRS) methodology (Case and Shiller, 1987, 1989), and is consistent with the assumption that housing values are generated by a log-normal diffusion process.[8] This means that over time individual housing values will appreciate at different rates,

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[6] See C.A. Calhoun and Y. Deng, "A Dynamic Analysis of Fixed- and Adjustable-Rate Mortgage Terminations," *Journal of Real Estate Finance and Economics*, 24(1-2):9-33, 2002.

[7] House price *drift* is defined here as the average rate of house price appreciation as determined by the appropriate market house price index, while *volatility* is defined as the variance in individual house price appreciation rates around the market average rate of appreciation.

[8] See C.A. Calhoun, "OFHEO House Price Indexes: HPI Technical Description," Washington, D.C.: Office of Federal Housing Enterprise Oversight, March 1996.

distributed randomly around the average rate of appreciation. Over time the cumulative rates of appreciation for individual homes will become more and more dispersed or diffuse, hence the reference to diffusion processes. These assumptions can be used to quantify the relationship between changes in house prices on average, and the likelihood of negative appreciation on individual properties that places some fraction of borrowers in a negative equity position. The imputed share of borrowers with negative equity is used as a proxy for the probability of negative equity for an individual borrower. The computed probabilities of negative equity were assigned to a series of categorical outcomes as summarized in Table B.1.

In the OFHEO model the default probability is positively related to the probability of negative equity and the prepayment probability is negatively related for all mortgage types. This is consistent with the expectation that those most likely to have negative equity will have the greatest difficulty selling their homes or refinancing their mortgages, and therefore be less likely to prepay their existing mortgages.

Burnout Effects

Mortgage termination studies have emphasized the importance of previous interest rate environments for distinguishing among borrowers more or less likely to exercise the prepayment option when the opportunity arises.[9] The tendency for the most responsive borrowers to prepay first, so that the remaining sample of borrowers are those with lower average conditional probabilities of prepayment, contributes to the observed seasoning or "burnout" of mortgage pools. OFHEO includes an indicator of whether the borrower has missed a previous refinance opportunity. The indicator variable equals one if the spread between the note rate on the mortgage and the quarterly average market rate of interest has been 200 basis points or greater during any two of the past 8 quarters. Borrowers who have missed previous refinance opportunities are predicted to have lower conditional probabilities of prepayment and higher conditional probabilities of default. Failing to refinance under favorable interest rate conditions may indicate the existence of other credit-related problems, such as failure to obtain an adequate property appraisal.

OFHEO's estimates indicate that default is positively related and prepayment is negatively related to burnout.

Relative Loan Size

The ability to bear the transactions costs of refinancing, or to weather economic stress and avoid default, will be correlated with the income level of the household. Given the lack of information in the historical Enterprise data on household income at origination, OFHEO used a measure of relative loan size as a proxy for the relative income level of the household.

[9] For example, see the discussions of borrower heterogeneity and path dependence in Bartholomew, L., J. Berk, and R. Roll, "Adjustable Rate Mortgages: Prepayment Behavior," *Housing Finance Review*, 7:31-46, 1988; and the discussion of burnout in Richard, S.F. and R. Roll, "Prepayments on Fixed Rate Mortgage Backed Securities," *Journal of Portfolio Management*, 15(3):73-82, 1989.

The loan size variable was defined as the ratio of the original loan amount relative to the average-sized Enterprise loan originated in the same state during the same origination year.

This variable was not included for the default function, but earlier estimates reported by OFHEO indicated that this variable has no effect on the default probability. It is strongly positively related to the prepayment probability, which is consistent with findings of other research. The effect on prepayment is less pronounced for ARM loans than for FRM loans.

Investor Loans

Occupancy status is included to distinguish mortgages on owner-occupied units from investor loans. Owner occupants should be less likely than investors to exercise the default option given the direct benefits they receive from the consumption of housing services, and owner occupants should be more likely to prepay than investors for non-financial reasons such as residential mobility.

In the OFHEO models the default probability is higher and the prepayment probability is lower for investor loans. The impact is somewhat greater for ARM loans.

Relative Spread

OFHEO approximated the call option value of the mortgage using the relative spread between the note rate and the current market rate. Positive values of the call option exist when the mortgage coupon exceeds the current market interest rate, and the borrower can benefit financially by refinancing to obtain a lower interest rate. The relative spread values were classified into categorical outcomes as summarized in Table B.1.

This variable was not included for the default equation, but earlier estimates reported by OFHEO researchers indicated that this variable has a positive relationship to default, at least for positive values of the relative spread. Prepayment probabilities are strongly positively related to the value of the prepayment option. For ARM loans the effect of this variable is offset by the ARM payment shock variable discussed below.

ARM Payment Shock

ARM borrows are subject to potential payment shock and higher default risk if interest rates increase relatively quickly over time. OFHEO included an interaction term between the relative spread variable just discussed and an indictor of an ARM loan to distinguish the impact of changes in market rates on ARM and FRM loans.

The ARM payment shock is negatively related to default probability, indicating that as market interest rates increase the impact of higher ARM payments is to increase default rates. This variable also has a positive impact on prepayment probabilities, but this is offset almost exactly by the impact of the relative spread variable, so that net effect of interest rate changes on ARM loans is reduced.

Yield Curve Slope

Expectations about future interest rates and differences in short-term and long-term borrowing rates associated with the slope of the Treasury yield curve influence the choice between ARM and FRM loans and the timing of refinancings and prepayments. OFHEO computed the yield curve slope as the ratio of the 10-year Constant Maturity Treasury (CMT) yield to the 1-year CMT yield, and assigned 4 categorical outcomes. A high value for the slope of the yield curve indicates relatively favorable short-term rates, increasing the likelihood that a borrower refinances to an ARM to take advantage of the lower initial coupons that can be offered by lenders.

The OFHEO model estimates indicate that prepayment probabilities are positively related to the slope of the yield curve for all model types.

Early ARM Payment

OFHEO included an indicator of early ARM payments for ARM loans seasoned less than 12 quarters (3 years). This accounts for the potential impact of changes in the ARM coupon from a low initial ("teaser") rate to the fully-indexed rate (index plus margin) over the first years of the loan. Including this variable distinguishes the impact of changes in the relative spread variable caused by changes in market interest rates from changes in mortgage note rates that are scheduled to occur regardless of changes in market rates (although these scheduled changes may be moderated to some extent by rapidly declining market rates).

OFHEO model estimates indicate that default is positively related and prepayment is negatively related to the early ARM payment effect.

Product Type Indicators

OFHEO created four product type indicators to account for the performance of non-standard loans relative to the standard 30-year FRM loan type: BALLOON, 15-Year FRM, 20-Year FRM, and GOVERNMENT.

Relative to 30-year FRM loans, default impacts are positive for Balloon and Government loans and negative for 15-year and 20-year FRM loans. Prepayment impacts are positive for all loan types except Government loans.

Benchmark Calibration Factors

OFHEO was required by statute to relate the rates of mortgage default applied in the RBC stress test to the historically high default rates that occurred in their historical benchmark experience. This was achieved by adjusting the intercept of the default function so that when the model is applied to loans from the historical benchmark period and locations it would project 10-year cumulative default rates equal to those observed for these loans. Separate

calibration constants were computed for each of the origination LTV categories. This implies that when the models are applied to the sample of benchmark loans the model predicts 10-year cumulative default rates identical to those observed for these loans.[10]

[10] The calibrated models produce a simple average of the 10-year cumulative default rates for Fannie Mae and Freddie Mac loans that equals the simple average of the 10-year cumulative default rates for each Enterprise that was observed for the benchmark period and locations. This replicates the manner in which historical default rates across different regions and time periods were estimated and compared to identify the historical benchmark.

Table B.1
OFHEO Single-Family Model Specifications

Variable Names and Outcome Categories	Variable Description and Impacts	Variable Included by Model Type and Loan Termination Status					
		FRM		ARM		OTHER	
		DF	PP	DF	PP	DF	PP
Mortgage Age $0 \le AGE \le 4$ $5 \le AGE \le 8$ $9 \le AGE \le 12$ $13 \le AGE \le 16$ $17 \le AGE \le 20$ $21 \le AGE \le 24$ $25 \le AGE \le 36$ $37 \le AGE \le 48$ $49 \le AGE$	Mortgage age in quarters. OFHEO adopted a categorical age variable for the final RBC rule. Previous model estimates for proposed RBC rule were based on quadratic specifications for mortgage age. Default probability increases with mortgage age up to 24 quarters (6 years) and declines thereafter. Prepayment probability increases and peaks first in quarters 9-12, declines in quarters 13-20 increases and peaks again in quarters 21-24, then declines thereafter.	X	X	X	X	X	X
Original LTV $LTV \le 60$ $60 < LTV \le 70$ $70 < LTV \le 75$ $75 < LTV \le 80$ $80 < LTV \le 90$ $90 < LTV$	LTV at origination. Default probability increases with LTV up to 70-75 LTV category, then declines for 75-80 and 80-90 categories. Rises again for above 90 LTV category, but only to level of 75-80 category. Prepayment probability highest for above 90 LTV category and then for below 60 LTV category. Lower for all other categories of LTV.	X	X	X	X	X	X
Probability of Negative Equity $0.0 \le PNEQ \le 0.05$ $0.05 < PNEQ \le 0.10$ $0.10 < PNEQ \le 0.15$ $0.15 < PNEQ \le 0.20$ $0.20 < PNEQ \le 0.25$ $0.25 < PNEQ \le 0.30$ $0.30 < PNEQ \le 0.35$ $PNEQ > 0.35$	Probability of negative equity computed using house price drift and volatility estimates from OFHEO HPI. LTV is updated using OFHEO HPI and combined with log-normal diffusion model of housing values based on volatility estimates from OFHEO HPI. Default probability is positively related to PNEQ and prepayment probability is negatively related to PNEQ for all mortgage types.	X	X	X	X	X	X
Burnout MISSED CHANCE TO REFINANCE	Burnout factor. Defined as missed opportunity to refinance. This occurs if coupon on the mortgage was greater than 200 basis points above market rate during any 2 quarters over the past 2 years. Default is positively related and prepayment is negatively related to burnout. May reflect loan-level differences in housing values and lack of equity to qualify for refinance.	X	X	X	X	X	X

Table B.1
OFHEO Single-Family Model Specifications

Variable Names and Outcome Categories	Variable Description and Impacts	Variable Included by Model Type and Loan Termination Status					
		FRM		ARM		OTHER	
		DF	PP	DF	PP	DF	PP
Relative Loan Size *LOAN SIZE* ≤ 0.40 0.40 < *LOAN SIZE* ≤ 0.60 0.60< *LOAN SIZE* ≤ 0.75 0.75 < *LOAN SIZE* ≤ 1.00 1.00 < *LOAN SIZE* ≤ 1.25 *LOAN SIZE* >1.50	Relative loan size. Defined as size of loan relative to average size of loan originated in the same state during the same origination year. Serves as a proxy for relative-income level of the borrower.						
	Not included for default equation, but earlier estimates reported by OFHEO indicated that this variable has no effect on default probability. Positively related to prepayment probability, which is consistent with findings of other research. Effect is less pronounced for ARM loans than for FRM loans.		X		X		X
Owner Occupancy Status INVESTOR LOAN	Investor loan indicator. This variable was included as a loan level dummy (0/1) variable for statistical estimation of the models. For the OFHEO stress test the percentage of investor owned loans is used.	X	X	X	X	X	X
	Default probability is higher and prepayment probability is lower for investor-owned loans. Impact is somewhat greater for ARM loans.						
Relative Spread *SPREAD* ≤ -0.20 -0.20 < *SPREAD* ≤ -0.10 - 0.10 < *SPREAD* ≤ 0 0 < *SPREAD* ≤ 0.10 0.10 < *SPREAD* ≤ 0.20 0.20 < *SPREAD* ≤ 0.30 0.30 < *SPREAD*	Refinance incentive variable approximated by the relative spread between the note rate and the current average market rate. This variable approximates the value of the prepayment option.						
	Not included for default equation, but earlier estimates reported by OFHEO researchers indicated that this variable has positive relationship to default, at least for positive values of the relative spread. Prepayment is strongly positively related to the value of the prepayment option. For ARM loans the effect of this variable is offset by the ARM payment shock variable discussed in the next panel.		X		X		X
ARM Payment Shock *PAYSHOCK* ≤ -0.20 -0.20 < *PAYSHOCK* ≤ -0.10 -0.10 < *PAYSHOCK* ≤ 0 0 < *PAYSHOCK* ≤ 0.10 0.10 < *PAYSHOCK* ≤ 0.20 0.20 < *PAYSHOCK* ≤ 0.30 0.30 < *PAYSHOCK*	ARM payment shock measure computed as interaction of ARM product type with relative spread variable, included to capture the impact of changes in ARM coupons on monthly payments. Included only in ARM model.						
	The ARM payment shock is negatively related to default probability, indicating that as market interest rates increase the impact of higher payments is to increase default rates. This variable also has positive impact on prepayment, but this is offset almost exactly by the impact of the relative spread variable, so that net effect of interest rate changes on ARMs is reduced.			X	X		

Table B.1
OFHEO Single-Family Model Specifications

Variable Names and Outcome Categories	Variable Description and Impacts	Variable Included by Model Type and Loan Termination Status					
		FRM		ARM		OTHER	
		DF	PP	DF	PP	DF	PP
Yield Curve Slope *YCSLOPE* < 1.0 1.0 ≤ *YCSLOPE* < 1.2 1.2 ≤ *YCSLOPE* < 1.5 *YCSLOPE* ≤ 1.5	Yield curve slope defined as ratio of 10-year CMT to 1-year CMT. This variable is included to account for changes in expectations of future rate increases that may lead borrows to refinance more quickly.		X		X		X
	Prepayment probabilities are positively related to the slope of the yield curve for all model types.						
Early ARM Payment ARM Loan and AGE ≤ 12	Early ARM payment effect. This variable is included to account for the impact of increases in ARM payments during first 3 years due to origination at artificially low "teaser" rates and resulting increases in ARM coupons.			X	X		
	Default is positively related and prepayment negatively related to the early ARM payment effect.						
Product Type Balloon 15-Year FRM 20-Year FRM Government	Product type indicators for OTHER products model.						
	Relative to 30-year FRM loans, default impact positive for Balloon and Government loans, negative for 15-year and 20-year FRM loans. Prepayment impact is positive for all except Government loans.					X	X
Benchmark Calibration *LTV* ≤ 60 60 < *LTV* ≤ 70 70 < *LTV* ≤ 75 75 < *LTV* ≤ 80 80 < *LTV* ≤ 90 90 < *LTV*	Benchmark calibration constants used to relate default rates in the stress test to those observed for OFHEO historical benchmark experience. These are not estimated in the statistical analysis, but were determined by comparing projected default rates with those on benchmark loans.	X		X		X	
	Positive adjustments to default function were required for lowest two LTV categories and for highest LTV category. All other categories required negative adjustments.						
Intercept	Constant term included for default and prepayment in all models.	X	X	X	X	X	X