UNITED STATES DISTRICT COURT
DISTRICT OF CONNECTICUT

ALEXIS M. HERMAN, Secretary of the United States Department of Labor,

Plaintiff,

vs.

STEVEN G. HASSENMILLER,
FRANK R. KRZYWICKI,
HUBERT J. BARNES,
CAMERON CHAMPLIN,
JOHN T. HIGGENS,
EUGENE HULL, JOHN W. OLSEN,
WILLIAM P. SHANNON,
U. ARTHUR SPOSE,
ROBERT K. HILTON,
ROBERT A. POLISKY,
GREGORY SALMINI,
ALAN SPOSE, FRED OTTO,
THOMAS DEBRINSKI,
THE CONNECTICUT PLUMBERS AND PIPEFITTERS PENSION FUND and THE CONNECTICUT PLUMBERS AND PIPEFITTERS PENSION PLAN,

Defendants.

Case No. 396-CV-01514
DJS

RULE 26(a)(2)(B) REPORT OF MARTIN R. HOLMER

September 30, 1997

Contents

1 Introduction and Opinion Summary

This report contains my opinions in connection with the complaint filed in the United States District Court for the District of Connecticut (the "Complaint") by the plaintiff, Alexis M. Herman, Secretary of the United States Department of Labor ("Department of Labor") against the defendants, Steven G. Hassenmiller ("Hassenmiller"), Frank Krzywicki, *et al.* (the "Trustees"), the Connecticut Plumbers and Pipefitters Pension Fund (the "Fund"), and the Connecticut Plumbers and Pipefitters Pension Plan (the "Plan").

The subject of the Complaint are the financial losses incurred by the Fund when a collection of mortgage securities and an interest-rate cap security (the "Portfolio") was sold in 1994. The Portfolio consisted of 78 securities bought and sold by the Fund between 1988 and 1994 during the dealings between the Trustees and Hassenmiller.

I have been asked to opine on (1) whether the 1988–1994 Portfolio was imprudently risky and (2) whether the Portfolio losses were caused by an imprudently risky Portfolio.

My study of the Portfolio consists of a Portfolio loss analysis and a Portfolio risk analysis, in addition to the preparation of a chronology of changes in the Portfolio's size, turnover, composition, and interest-rate environment during the 1988–1994 period.

My loss analysis concludes that 23 of the 78 securities in the Portfolio were sold at a loss relative to the investment returns that were actually received by the Fund's bond-and-stock investment managers during each security's holding period. The total financial loss on these 23 securities, including opportunity costs since each loss was incurred, is calculated using conservative assumptions to be about $13.1 million, as of September 30, 1995.

My risk analysis concludes that before 1991, the Portfolio was relatively small, had low turnover, and given the securities held in the Portfolio, was not imprudently risky during the 1988–1990 period. After the four-fold growth in the size of the Portfolio during 1991, the composition and turnover of the Portfolio changed markedly. The securities that had composed the earlier Portfolio were sold and replaced with very different kinds of mortgage securities and an interest-rate cap security. The turnover of the Portfolio rose sharply following 1991 as the average holding period of securities dropped. After 1991 the risk of the Portfolio also increased substantially (more than a three-fold increase using one common measure of risk). This increase in the

Portfolio's risk caused the risk-adjusted rate of return on the Portfolio to fall well below the level of risk-adjusted rates of return on other securities available in the capital markets. I conclude that the procedures by which these securities were purchased for the Portfolio were imprudent and that after 1991 the Portfolio was composed of securities whose volatile nature created an imprudent level of Portfolio risk. The nature of this risk was to experience losses in a rising interest rate scenario, which is exactly what happened during 1994.

The opinions expressed herein are based on my professional skills, training, and experience, as well as on the findings of the loss and risk analyses described below.

2 Chronology of Portfolio Events

In this section of the report, I present historical information about the Portfolio's size, turnover, and composition, and about the pattern of interest-rate movements in the capital markets. These facts provide contextual information for the Portfolio loss and risk analyses that are presented in subsequent sections of the report.

2.1 Portfolio's Size

As Figure 1 on the following page shows, the size of the Portfolio was relatively small during the 1988–1990 period and then grew substantially during 1991, mostly at the end of the year. From an initial size of about five million dollars in securities, the Portfolio grew to a size that fluctuated in the twenty to twenty-five million dollar range beginning in late 1991. As the following discussion of the Portfolio's turnover and composition makes clear, the larger Portfolio was very different in character than the smaller Portfolio held before 1991.

2.2 Portfolio's Turnover

One clear change in the character of the Portfolio, following its 1991 growth, is shown in Figure 2 on page 5. The pre-1991 Portfolio was largely a buy-and-hold portfolio, while the Portfolio after 1991 exhibited high turnover. Monthly purchases were often in excess of five million dollars and not infrequently above ten million dollars. This is a high volume of purchases for a Portfolio whose size is in the twenty to twenty-five million dollar range. As the buy-date and sell-date data presented below in the loss analysis indicate, one consequence of this higher rate of security turnover was that the average length of security holding periods fell substantially after 1991.

2.3 Portfolio's Composition

The change in the composition of the Portfolio, which occurred at the same time during 1991, had a significant effect on the level of the Portfolio's interest-rate risk as will be shown in the risk analysis below. Here, I describe the types of securities held in the Portfolio and explain how the sensitivity of the securities' market value to changes in interest rates is determined by

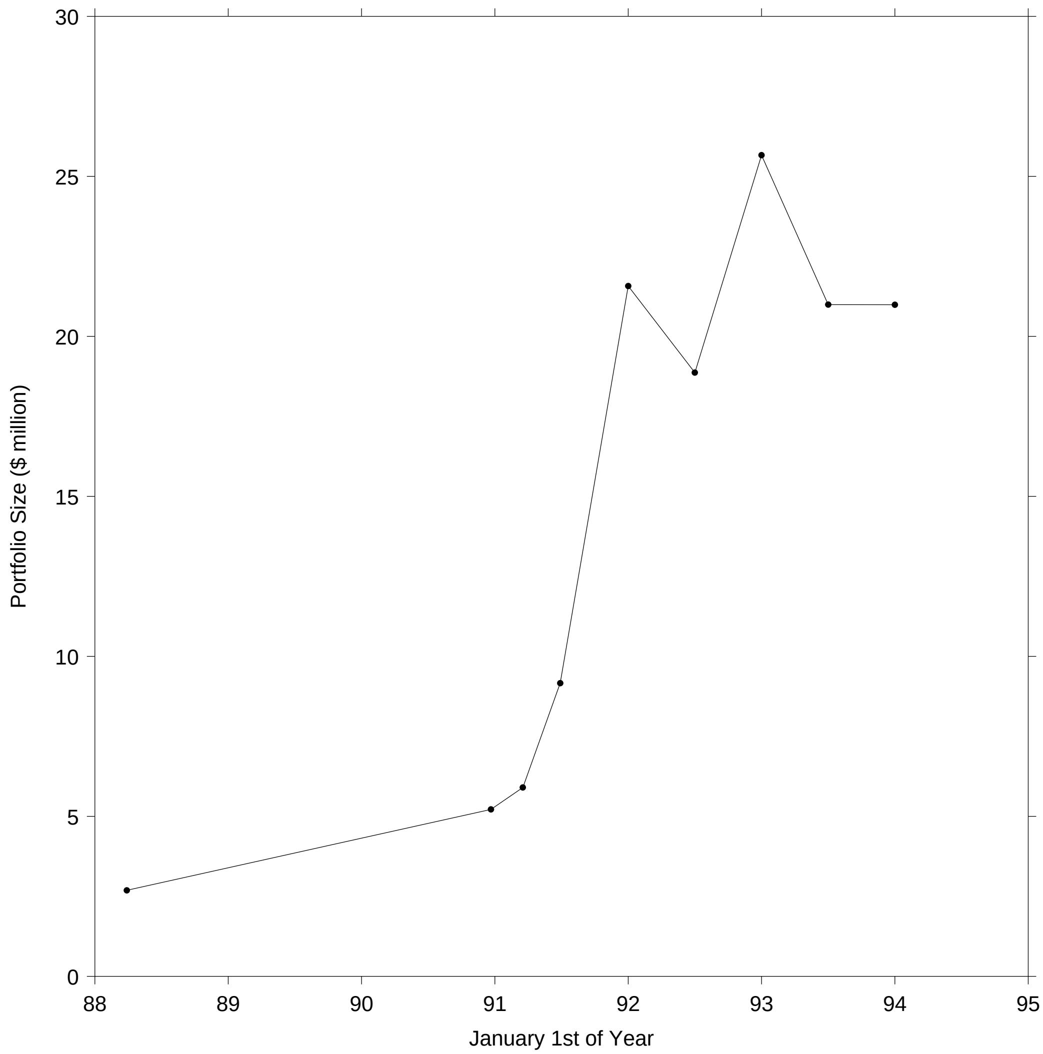

Figure 1: **Size of Portfolio at Selected Dates during 1988–1993 Period**. Size measured by sum of buy price of securities held at each date and expressed in millions of dollars.

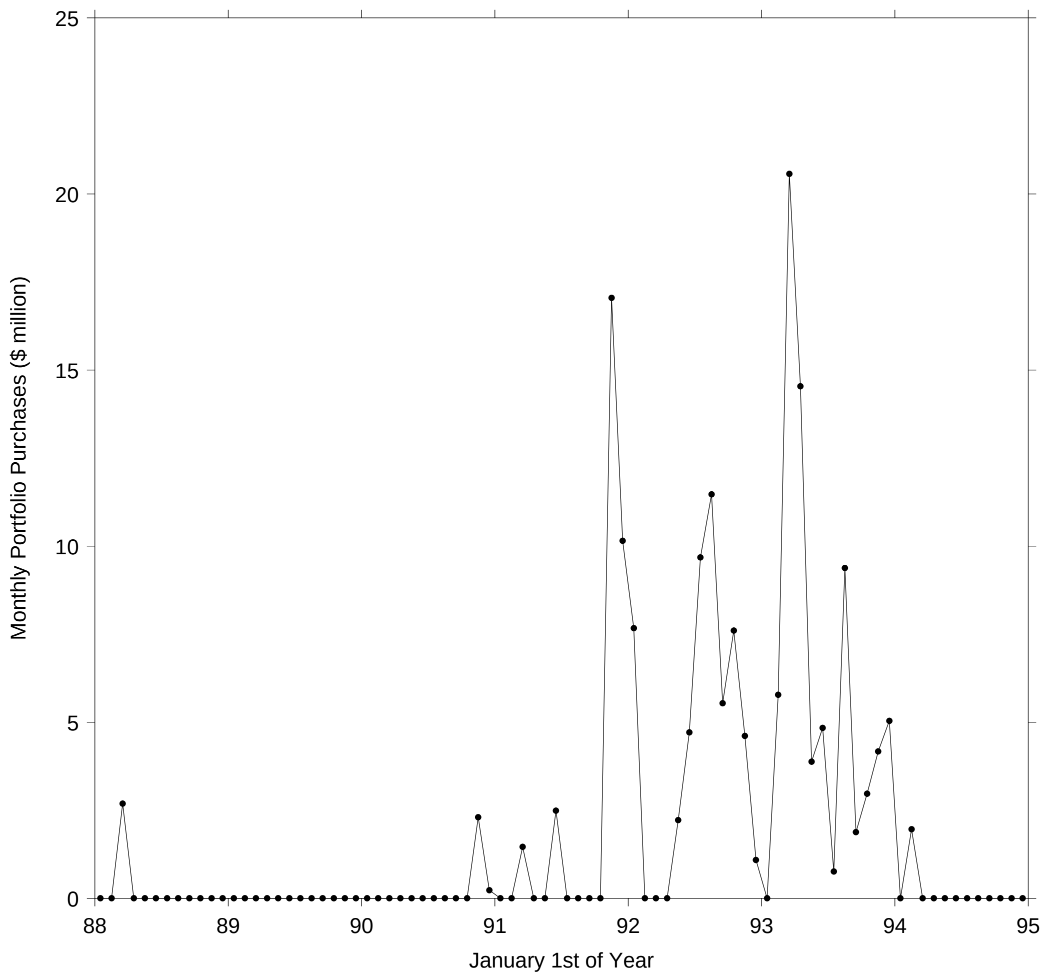

Figure 2: **Monthly Purchases for Portfolio during 1988–1994 Period**. Purchases measured by sum of buy price of securities bought for the Portfolio during each month and expressed in millions of dollars.

their nature. Because all but one of the 78 securities held in the Portfolio during the 1988–1994 period were mortgage-backed securities, it is essential to begin with an introductory discussion of these complex securities.

Introduction to Mortgage-Backed Securities

This introduction quotes extensively from two investor guides published by the Public Securities Association (PSA 1993, PSA 1994). This is a lengthy introduction, but it is no longer than required by the complexity of the mortgage-backed securities that the Fund held in its Portfolio.

What are mortgage-backed securities? Mortgage securities represent an ownership interest in mortgage loans made by financial institutions (savings and loans, commercial banks, or mortgage companies) to finance the borrower's purchase of a home or other real estate. Mortgage securities are created when these loans are packaged, or pooled, by issuers or servicers for sale to investors. As the underlying mortgage loans are paid off by the homeowners, the investors receive payments of principal and interest.

Investors may purchase mortgage securities when they are issued or afterward in the secondary market. Investments in mortgage securities are typically made by large institutions when the securities are issued. These securities may ultimately be redistributed by dealers in the secondary market.

The most basic mortgage securities, known as pass-throughs, participation certificates (PCs), or simply MBS, represent a direct ownership interest in a pool of mortgage loans. (PSA 1993, p. 1).

How do MBS differ from other fixed-income securities? With fixed-income securities such as corporate bonds, an investor effectively lends money to the bond issuer in return for a stated rate of interest (coupon rate) over the life of the bond. The investor receives a repayment of the principal, namely the face value of the bond, in a single lump sum when the bond matures.

Investors in MBS also earn a coupon rate of interest, but they receive repayments of their principal in increments over the life of the MBS, as the underlying mortgage loans are paid off, rather than in a single lump sum at maturity.

Because the timing and speed of principal repayments may vary, the cash flow on MBS is irregular. If homeowners whose mortgages are in a pool sell their homes, refinance their loans to take advantage of lower interest rates, prepay their mortgages for some other reason, or default on their loans, the principal is distributed on a pro rata basis to investors in MBS. When this happens, the investors' remaining interest in the MBS is reduced by the amount of the prepayments. Because the principal is reduced over the life of the MBS, the interest income also decreases in terms of absolute dollars paid to investors.

MBS are sold and traded in terms of their assumed average life rather than their maturity dates. The average life is the average amount of time that each principal dollar in the pool is expected to be outstanding. However, some mortgage loans could remain outstanding for the entire life of the original loans — typically 30 years.

As with any fixed-income security, the yield on an MBS investment depends on the purchase price in relation to the coupon rate and the length of time the principal is outstanding.

To compare the value of an MBS with other fixed-income investments, some prepayment assumptions, based on historic prepayment rates, are factored into the price and yield. The more accurate the prepayment projections, the more realistic the yield estimates.

While most bonds pay interest semiannually, mortgage securities usually pay interest and principal monthly depending on the terms of the issue. Pass-through MBS provide monthly payments.

MBS also tend to carry higher coupon rates than U.S. Treasury securities. In part, this is because the interest rates charged on mortgage loans are higher than the interest rates charged to the U.S. Government. But the higher rates on MBS also reflect the level of investment risk created by the prepayment uncertainty. Investors in MBS may have their principal returned to them sooner (or later) than they expect when they make their investment. (PSA 1993, pp. 4–6).

How are mortgage prepayment speeds measured? The realization of the average life and yield estimates for an MBS depends on the accuracy of the prepayment assumptions used to evaluate the MBS at the time of its purchase. Different standard and proprietary prepayment rate models exist, but one of the most common ways of expressing prepayment rates is in terms of the PSA Standard Prepayment Model. Developed by the Public Securities Association in 1985, the PSA model assumes that new mortgage loans are less likely to be prepaid than somewhat older, more seasoned mortgage loans. Projected and historical prepayment rates are often expressed as percentage of PSA (*e.g.*, 150% PSA). (PSA 1994, p. 8).

Who issues MBS? The majority of MBS are issued and/or guaranteed by an agency of the U.S. Government, the Government National Mortgage Association (GNMA or Ginnie Mae), or by government-sponsored enterprises such as the Federal National Mortgage Association (FNMA or Fannie Mae) and the Federal Home Loan Mortgage Corporation (FHLMC or Freddie Mac). Ginnie Mae is a government-owned corporation within the Department of Housing and Urban Development. Fannie Mae and Freddie Mac are chartered by Congress, but owned by stockholders. These agencies buy qualified mortgage loans from the financial institutions that originate them, securitize the loans (*i.e.*, pool them into MBS), and distribute the MBS securities through the dealer community. (PSA 1993, p. 2).

What are the default risks of MBS? Issuers of MBS are typically very selective in choosing the mortgages which make up their pools. Beyond the basic security of the mortgage loans themselves, MBS issued by Ginnie Mae, Fannie Mae, and Freddie Mac carry additional guarantees which enhance their creditworthiness.

Ginnie Mae guarantees the timely payment of principal and interest on all of its pass-through MBS, and its guarantee is backed in turn by the full faith and credit of the U.S. Government. This means that holders of MBS issued by Ginnie Mae will receive their payments promptly each month, whether or not mortgage payments are collected, and they will receive full repayment of principal even if the mortgages in the pool default.

Fannie Mae guarantees timely payment of both principal and interest on its MBS, whether or not the payments have been collected from the borrower.

Freddie Mac also guarantees the timely payment of both principal and interest on its MBS.

Nether Fannie Mae's nor Freddie Mac's guarantees are backed by the full faith and credit of the U.S. Government. However, the credit markets consider the securities of both entities to be nearly equivalent to those issued by agencies which have the full-faith-and-credit guarantee. (PSA 1993, pp. 11–12).

What are the interest-rate risks of MBS? MBS are often priced at a higher yield than Treasury and corporate bonds, but their opportunities of profit (and loss) are also greater. They may be sold at par, or at a premium or a discount, to their face value. As with other fixed-income securities, MBS prices fluctuate in response to changing interest rates: when interest rates fall, prices rise, and vice versa.

Interest rate movements have an additional impact on MBS because they affect prepayment rates, which in turn affect yields. When interest rates decline, prepayment speeds generally accelerate because homeowners may refinance their mortgages at a lower interest rate and thus reduce their monthly obligation. Rising interest rates may decrease the assumed prepayment speed. The impact on yield will depend on whether the MBS was purchased at a premium or a discount. Investors who may wish to sell their mortgage securities prior to maturity should take care to understand how the direction of interest rates might affect the value of their MBS holdings. This admonition applies equally to institutions such as pension funds that are required to use market prices to account for the value of their assets. Market-value accounting causes unrealized gains and losses to be recognized as equivalent to gains and losses on securities sold before maturity.

MBS also have implied call and extension risks, which are sometimes referred to as negative convexity. The implied call risk means that investors may have their principal returned to them sooner than expected, because of accelerated (*i.e.*, higher because interest rates have fallen) prepayment speeds. In this case, investors may be forced to reinvest the returned principal at lower interest rates. On the other hand, the average life of the MBS may turn out the be longer than anticipated because prepayment rates are slower (*i.e.*, lower because interest rates have risen), creating an implied extension risk. In this scenario, investors might miss an opportunity to earn higher prevailing rates of interest on their principal.

In general, before investing in an MBS, investors should consider the expected performance of that security if interest rates should rise, fall, or remain the same. (PSA 1993, pp. 13–14).

What are MBS derivatives? Beginning in the mid-1980s, MBS began to be used to create other mortgage securities that had different characteristics than the MBS from which they were derived. MBS serve as collateral for these "synthetic" (PSA 1994, p. 4) or derivative securities, supplying the monthly interest and principal payments used to make monthly payments on the derivatives. As explained below, there are two major categories of MBS derivatives: MBS strips and CMOs.

What are MBS IO and PO strips? Stripped MBS, first introduced in 1986, are created by segregating the cash flows from the underlying MBS to create two or more new securities, each with a specified percentage of the underlying MBS's principal payments, interest payments, or a combination of the two. For example, the cash flow on an 8 percent pass-through MBS might be redistributed to create one new security with a 10 percent coupon and another with a 6 percent coupon.

MBS may be partially stripped so that each investor class receives some interest and some principal. When securities are completely stripped, all the underlying MBS interest is distributed to one type of derived security, known as an interest-only (IO) strip, and all the underlying MBS principal distributed to another, known as a principal-only (PO) strip.

The market values of IOs and POs are very sensitive to fluctuations in prepayment rates and interest rates, making them more volatile than standard pass-throughs. POs, for example, increase in value as interest rates decline, and decrease in value as interest rates rise. Price behavior also depends on whether the mortgage collateral was purchased at a premium or a discount to its par value. Prepayments on discount coupon POs generally are much lower than prepayments on premium coupon POs. IOs can function as excellent portfolio hedging vehicles, because prepayments induced by a decline in interest rates cause the value of an IO strip to move in the opposite direction from many other mortgage and fixed-income securities. (PSA 1993, pp. 10–11).

What are the interest-rate risks of PO strips? In purchasing a PO strip, investors pay a price deeply discounted from the face value and ultimately receive the entire face value through scheduled (*i.e.*, mortgage-amortizing) payments and unscheduled prepayments. The market values of POs are extremely sensitive to prepayment rates and therefore interest rates. If interest rates are falling and prepayments rising, the value of the PO will increase. This is because investors get their principal payments sooner than originally expected, making its return better than expected. On the other hand, if interest rates rise and prepayments fall, the value of the PO will drop.

This is because investors get their principal payments later than originally expected, making its return worse than expected. (PSA 1994, pp. 15–16).

What are the interest-rate risks of IO strips? IO strips are sold at a deep discount to their notional principal amount, namely the principal amount used to calculate the amount of interest due. They have no face or par value. As the notional principal amortizes and prepays, the IO cash flow declines.

Unlike POs, IOs increase in value when interest rates rise and prepayment rates fall; consequently they are often used to hedge portfolios against interest rate risk. IO investors should be mindful that if prepayment rates are high, they may actually receive less cash back than they initially invested.

> The structure of IOs and POs exaggerates the effect of prepayments on cash flows and market value. The heightened risk associated with these securities makes them unsuitable for certain investors. (PSA 1994, p. 16).

It is important to underscore this last point made by PSA. The "heightened" interest-rate risk of an IO strip means that, even though the payment of the principal and interest on the underlying MBS might be guaranteed by Ginnie Mae, Fannie Mae, or Freddie Mac, investors in IO strips are exposed to a degree of interest-rate risk that is sufficient to cause, in some interest-rate scenarios, losses measured relative to the price paid for the security. In plain terms, the default guarantee does nothing to prevent the possibility of financial losses to investors in IO strips.

As this introduction to mortgage-backed securities moves on to CMOs, it will become clear that many mortgage-backed securities are quite sensitive to changes in interest and prepayment rates, and therefore, quite risky despite the guarantee against mortgage default losses.

What are CMOs? The CMO (collateralized mortgage obligation, also known as a real estate mortgage investment conduit or REMIC) is a multi-class bond backed by pool of mortgage pass-through MBS. CMOs are usually collateralized by Ginnie Mae, Fannie Mae, or Freddie Mac pass-through MBS. In structuring a CMO, an issuer distributes cash flow from the underlying MBS collateral over a series of classes (called tranches) which comprise the bond issue. Each CMO is a set of two or more tranches, each having average lives and cash-flow patterns designed to meet specific investment objectives. The average life expectancies of the different tranches in four-tranche sequential-pay CMO, for example, might be 2, 5, 7, and 20 years. Some CMOs issued recently have had more than 50 tranches.

As the payments on the underlying MBS collateral are collected, the CMO issuer first pays the coupon rate of interest to the bondholders in each tranche. All scheduled and unscheduled principal payments generated by the collateral, as mortgage loans are repaid or prepaid, go first to investors in the first tranches. Investors in later tranches do not start receiving principal payments until the prior tranches are paid off. This basic type of CMO is known as a sequential pay or plain vanilla CMO. Any collateral remaining after the final tranche has been paid is known as a residual.

Sometimes CMOs are structured so that the prepayment and/or interest-rate risks are transferred from one tranche to another. Prepayment stability is improved in some tranches because other tranches absorb more of the risk of prepayment variability. Therefore, it is important to know the characteristics of other tranches in the CMO before selecting a tranche as an investment. (PSA 1993, pp. 7–8).

Each CMO tranche has an estimated first payment date on which investors can expect to begin receiving principal payments and an estimated last principal payment (or maturity) date on which they can expect their final dollar of principal to be returned. The period before principal payments begin in the tranche, when investors receive interest-only payments, is known as the lockout period. The period during which principal repayments are expected to occur is called the window. Both first and last principal payment dates are estimates based on prepayment assumptions and can vary according to actual prepayments made on the underlying mortgage loans. (PSA 1994, pp. 11).

The types of CMO tranches that are relevant to this report include: PAC and TAC tranches and their companion (or support) tranches, super-PO tranches, and inverse-floater tranches. Note that the terms REMIC and CMO are used interchangeably here, as they are in both the PSA documents.

What are PAC CMO tranches? PAC (Planned Amortization Class) tranches use a mechanism similar to a sinking fund to establish a fixed principal payment schedule that directs cash-flow irregularities caused by faster- or slower-than-expected prepayments away from the PAC tranche and toward another companion or support tranche (see below). With a PAC tranche, the yield, average life, and lockout periods estimated at the time of investment are more likely to remain stable over the life of the security.

PAC payment schedules are protected by priorities which assure that PAC payments are met first out of principal payments from the underlying MBS mortgage loans. Principal payments in excess of the scheduled payments are diverted to non-PAC tranches in the REMIC structure called companion or support tranches because they support the PAC schedules. In other words, at least two bond tranches are active at the same time, a PAC and a companion tranche. When prepayments are minimal, the PAC payments are met first and the companion may have to wait. When prepayments are heavy, the PAC pays only the scheduled amount, and the companion class absorbs the excess. Type I PAC tranches maintain their schedules over the widest range of actual prepayment speeds, say from 100% to 300% PSA. Type II and Type III PAC tranches can also be created with lower priority for principal payments from the underlying MBS than the primary or Type I tranches. They function as support tranches to higher-priority PAC tranches and maintain their schedules under increasingly narrower ranges of prepayments.

PAC tranches are now the most common type of REMIC tranche, comprising over 50% of the new-issue market. Because they offer a high degree of investor cash-flow certainty, PAC tranches are usually offered at lower yields than on other more volatile tranches. (PSA 1994, pp. 12–13).

As will be discussed below, not one of the 78 Portfolio securities was a PAC tranche.

What are TAC CMO tranches? TAC (Targeted Amortization Class) tranches also provide cash-flow certainty and a fixed principal payment schedule, based on a mechanism similar to a sinking fund, but this certainty applies at only one prepayment rate rather than a range. If prepayments are higher or lower than the defined rate, TAC bondholders may receive more or less principal than the scheduled payment. TAC tranches' actual performance depends on their priority in the REMIC structure and whether or not PAC tranches are also present. If PACs are also present, the TAC tranche will have less cash-flow certainty. If no PACs are present, the TAC provides the investor with some protection against accelerated prepayment speeds and early return of principal. The yields on TAC tranches are typically higher than yields on PAC tranches but lower than yields on companion tranches.

(PSA 1994, pp. 13–14).

As will be discussed below, not one of the 78 Portfolio securities was a TAC tranche.

What are companion or support CMO tranches? Every REMIC that has PAC or TAC tranches in it will also have companion tranches (sometimes called support bonds) which absorb the prepayment variability that is removed from the PAC and TAC tranches. Once the principal is paid to the active PAC and TAC tranches according to the schedule, the remaining excess or shortfall is reflected in payments to the active companion tranche.

> *The average life of a companion tranche may vary widely, increasing when interest rates rise and decreasing when rates fall.* (PSA 1994, p. 14, emphasis in original).

What are super-PO CMO tranches? A companion tranche structured as a PO strip is called a Super PO. (PSA 1994, p. 16).

As will be discussed below, after 1991 the Portfolio contained a number of super-PO CMO tranches, as well as several PO MBS strips.

What are the interest-rate risks of super-POs? Because a super-PO is a companion tranche, the timing of principal receipt is even more sensitive to changes in interest rates and MBS prepayment rates than is a PO strip. This means that the payment of principal accelerates very fast when a fall in interest rates generates more than the usual prepayment of underlying MBS principal and the payment of bond principal decelerates markedly when a rise in interest rates generates less than the usual prepayment of underlying MBS principal. Because super POs pay no interest, the length of time it takes to get paid the principal is the sole determinant of market value. This means that the magnified sensitivity of the timing of principal payments to changes in interest and prepayment rates causes the price of a super PO to be very volatile. In other words, super POs exhibit extremely high degrees of call and extension risk, making their market values highly sensitivity to changes in interest rates. Higher interest rates lead to a lower price because principal payments are delayed, while lower interest rates lead to a higher price because principal payments are accelerated.

What are inverse-floater CMO tranches? Offered as early as 1986, floating-rate REMIC tranches carry interest rates that are tied in fixed relationship to an interest rate index, such as the London Interbank Offered Rate (LIBOR), the Constant Maturity Treasury (CMT), or the Cost of Funds Index (COFI), subject to an upper limit or cap and sometimes to a lower limit or floor. The performance of these investments also depends on the way interest rate movements affect prepayment rates and average lives.

Sometimes the interest rates on these tranches are stated in terms of a multiplier formula based on the designated index, meaning that they move up or down by more than one basis point (1/100 of one percent) for each basis point increase or decrease in the index. These so-called superfloaters offer leverage when rates rise. The interest rates on inverse floaters move in a direction opposite to the changes in the designated index and offer leverage to investors who believe rates may move down. The potential for high coupon income in a rally (*i.e.*, when interest rates fall) can be rapidly eroded when prepayments speed up in response to falling interest rates. All types of floating-rate tranches may be structured as PAC, TAC, companion, or sequential tranches. (PSA 1994, pp. 16–17).

As will be discussed below, after 1991 the Portfolio contained a number of CMO companion (or support) tranches that were inverse superfloaters.

What are the interest-rate risks of inverse floaters? Inverse superfloaters that are structured as companion tranches are among the most volatile of all CMO tranches and much more sensitive to changes in interest rates than regular fixed-rate bonds.

A fixed-rate bond loses market value when interest rates rise because its coupon interest rate is now below the coupon rate available on newly issued bonds. The market value of the old bond drops enough so that its yield to maturity rises up to the coupon rate available on newly issued bonds. The decline in market value of an inverse superfloater companion tranche is much larger than for a fixed-rate bond of similar maturity because just as market interest rates are rising, the coupon interest rate on the tranche is dropping by a multiple of the rise in the index rate, making it an even worse substitute for newly issued bonds. As a result, the market value of the tranche must fall by much more before its yield to maturity equals currently available interest rates. And because the inverse superfloater is a companion tranche, the rise in interest rates and fall in prepayment rates causes the average life of the tranche to increase markedly. The combination of a coupon rate that is far below current interest rates and a much longer average life causes a substantially larger drop in the market value of the tranche than in the price of fixed-rate bond.

Of course, falling interest rates lead to major increases in the inverse superfloater's coupon rate, which does lead to a price increase. But this rise in market value is attenuated by the dramatic shortening of the companion tranche's average life caused by the fall in interest rates and rise in prepayment rates. Short-term securities have little price volatility because the length of time that the higher coupon rate can be collected is so short.

An indicative example will clarify the extreme magnitude of the price sensitivity to changes in interest rates for inverse superfloaters that are structured as companion tranches. Consider the PB tranche of the FHLMC REMIC 1611, which was issued at the end of November, 1993, and held in the Fund's Portfolio from December 30, 1993, until April 4, 1994, as shown in Table 2 on page 50.

The offering circular supplement (or prospectus) for this Freddie Mac REMIC is attached to this report. The front page of this offering circular supplement (p. S-1 marked CPP006875) indicates that this inverse floater is structured as a support or companion tranche in a REMIC that contains 32 PAC tranches out of a total of 43 tranches. The PB tranche was priced at 101.35 percent of face value (p. S-34 marked CPP006908) under an assumed prepayment speed of 235% PSA, which implies an average life of 10.3 years (p. S-1 marked CPP006875). The initial coupon rate was 19 percent, there was a maximum coupon rate (cap) of 19 percent, a minimum coupon rate (floor) of 0 percent, and the inverse superfloater coupon formula (p. S-3 marked CPP006877) uses LIBOR as the index rate and has a multiplier of over six: `38.0% - (LIBOR x 6.08)`.

This formula implies that a rise in LIBOR to 6.25 percent would reduce the PB tranche's coupon rate to zero. If this rise in interest rates caused prepayments rates to fall from the assumed 235% PSA to 95% PSA, the average life of the PB tranche would more than double from 10.3 to 24.2 years (p. S-28 marked CPP006902). Note that the price of a zero-coupon bond with a 24-year maturity and with an annual yield of 6.25 percent is about 23 percent of face value, which is far lower than a purchase price of 101.35 percent of face value.

On the other hand, a fall in LIBOR would not change the coupon rate because it was already at its maximum value. But a fall in interest rates that raised prepayment rates from 235% PSA to just 350% PSA would cause the PB tranche's average life to shorten from 10.3 years to 2.1 years (p. S-28 marked CPP006902). The value of the high 19 percent coupon rate is greatly attenuated by this call risk.

In fact, during the four months that the PB tranche was held in the Portfolio, interest rates rose sharply as will be shown below in the discussion of the Portfolio's interest-rate environment beginning on page 18. Although Table 2 on page 50 shows that the Fund received nearly $420,000 in principal and interest payments from the PB tranche, the Fund also suffered a capital loss of about $2,560,000, which is 61 percent of the original investment, because the market value of the tranche fell sharply due to the interaction between the lower coupon rate and longer average life.

This completes the report's introduction to mortgage-backed securities. Given this background, I describe briefly the changing security composition of the Portfolio, and then conclude this chronology of events with a description of the Portfolio's interest-rate environment.

Pre-1991 Portfolio

Before 1991, the Portfolio was composed of just two types of mortgage securities: fixed-rate pass-through MBS and PO strips. As the risk analysis will show, this pre-1991 Portfolio had a modest degree of interest-rate risk when compared to the post-1991 Portfolio. Following the 1991 growth in the size of the Portfolio, the securities held in the earlier period were sold and replaced by very different kinds of mortgage securities. Therefore, just as additional money from the Fund was being invested in this Portfolio, its composition changed markedly.

Post-1991 Portfolio

After 1991, the Portfolio was invested in IO strips, POs and super POs, inverse floaters, and in one interest-rate cap security.

This interest-rate cap was the only non-mortgage security held in the Portfolio. It was a security that had a maturity of ten years, paid no principal, and paid interest only if one-month LIBOR was above 8.5 percent. If LIBOR was above that level, the monthly interest payment was one-twelfth of the product of seven million dollars and the spread of LIBOR above 8.5 percent. If LIBOR was below that level, the interest-rate cap paid no interest. Clearly, the market value of the interest-rate cap was very sensitive to movements in interest rates because if LIBOR dropped and stayed below 8.5 percent over the ten-year life of the cap, the interest-rate cap would generate no cash flow.

With the larger, post-1991 Portfolio invested in these kinds of interest-rate sensitive mortgage-backed securities and the interest-rate cap, and with the new high-turnover style of portfolio management, the qualitative nature of the Portfolio had changed markedly. That these new kinds of securities were very sensitive to interest rates is confirmed by the fact (see CPP001267) that a number of these securities were assigned V8, V9, or V10 Fitch Volatility Ratings, which are the highest interest-rate sensitivity measures assigned in the CMO Market Risk Ratings produced since 1992 by Fitch Investors Service, an independent rating agency.

Given the heightened interest-rate sensitivity of the securities held in the post-1991 Portfolio, it is important to review the historical pattern of interest rate movements during the 1988–1994 period.

2.4 Portfolio's Interest-Rate Environment

As the Portfolio risk analysis will make clear, the major risk to the Portfolio was from changes in the market value of its securities caused by changes in the level of interest rates. The amount of interest-rate risk present in any portfolio depends on (1) the sensitivity of each security's market value to changes in interest rates (an attribute of each security) and on (2) the volatility of interest rates in the capital markets (a characteristic of a portfolio's environment).

The Portfolio risk analysis combines these two factors to measure the Portfolio's risk and the effects of that risk on the Portfolio's risk-adjusted rate of return. Here I present information on the historical volatility of interest rates which demonstrates that the rise in interest rates during 1994 was not unprecedented.

First consider the history of interest rates on long-term U.S. Treasury bonds over the past two-thirds of a century. Figure 3 on the following page indicates that changes in rates of the magnitude experienced during 1994 are not uncommon, especially during the more volatile recent decades. It is widely known in the capital markets that a change in Federal Reserve Board monetary policy has produced higher volatility in interest rates since the 1970s.

Figure 3: **Yields on Long-Term U.S. Treasury Bonds at End of Years 1926–1994**.

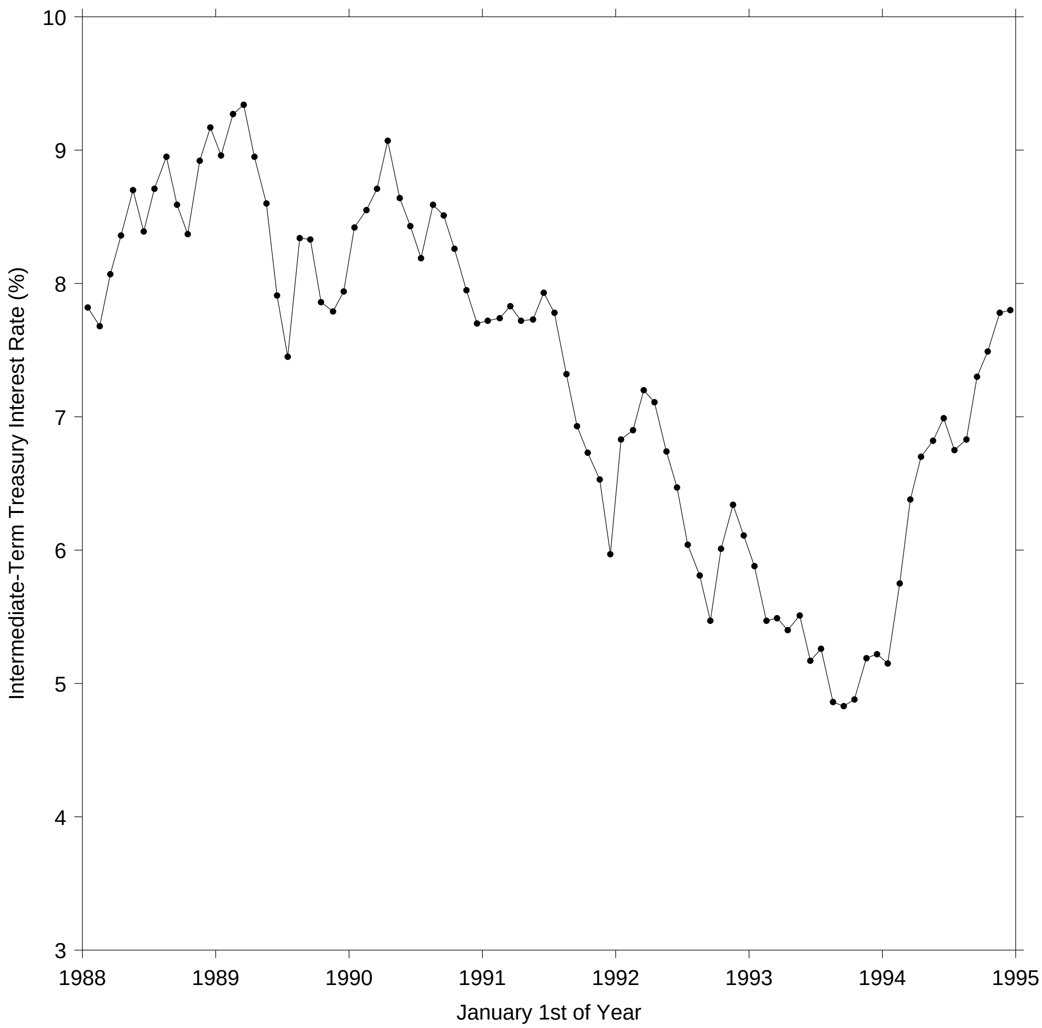

Figure 4: **Yields on Intermediate-Term U.S. Treasury Notes during 1988–1994 Period**.

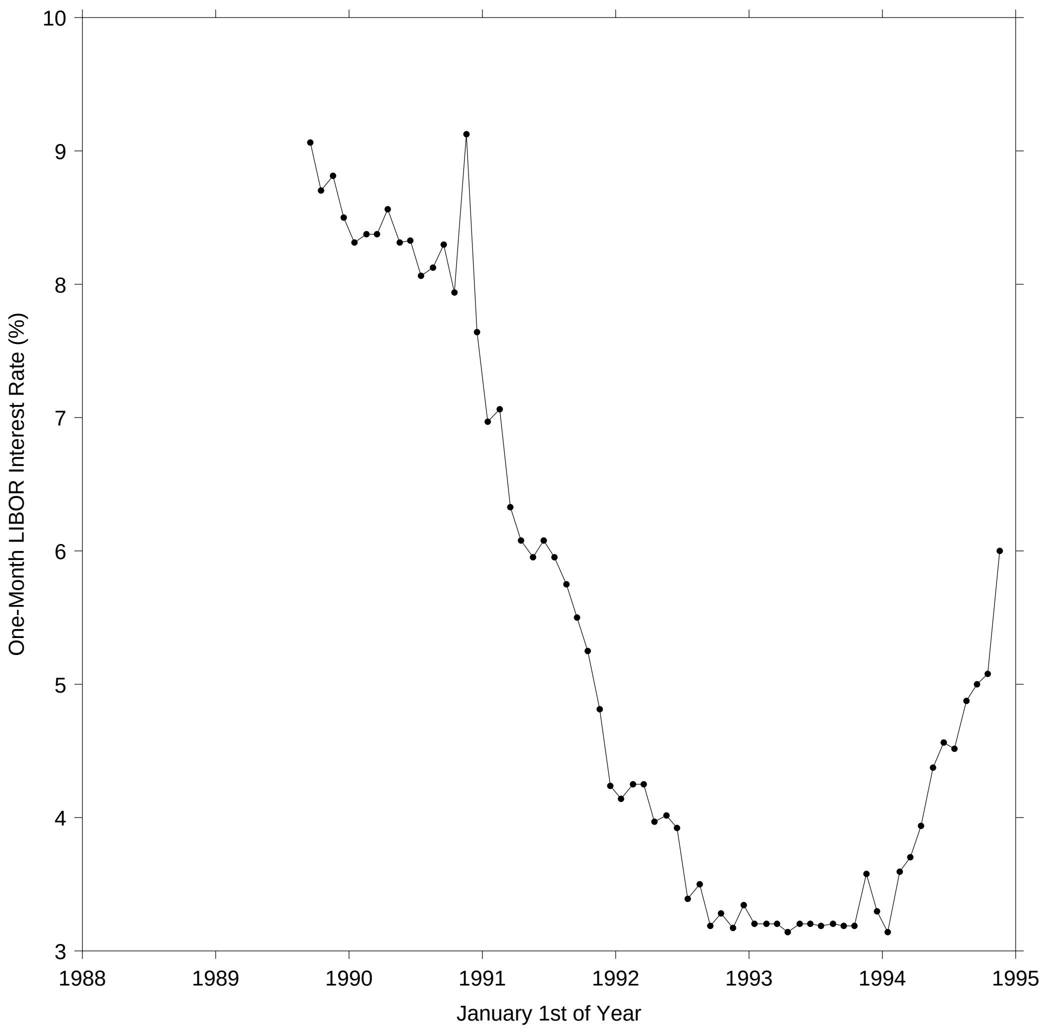

Figure 5: **One-Month London Interbank Offering Rate (LIBOR) during 1989–1994 Period**.

Figure 4 on page 20 shows movements in interest rates on intermediate-term U.S. Treasury notes during the period of time that the Trustees were dealing with Hassenmiller on the Portfolio. During the first three years of this 1988–1994 period, interest rates moved in the 8 percent to 9 percent range. From 1991 through late 1993 rates fell from about 8 percent to about 5 percent. Then beginning in late 1993 rates rose from about 5 percent to about 6.5 percent in mid-1994 and to nearly 8 percent by the end of 1994.

Figure 5 on the preceding page shows the level of the one-month LIBOR over the 1989–1994 period. Movements in LIBOR are important because the cash flow and market value of the interest-rate cap in the Portfolio was very sensitive to the difference between the actual LIBOR and 8.5 percent. If LIBOR was above 8.5 percent, the interest-rate cap paid interest on the seven million dollar principal at a coupon interest rate equal to the actual LIBOR minus 8.5 percent. If LIBOR was below 8.5 percent, the coupon interest rate was zero. The seven million dollar principal amount was a notional amount used in interest calculations only; the interest-rate cap security called for the payment of no principal over its ten-year life. As the loss analysis below will show, this security was purchased in mid-1991 and sold in mid-1994, during which time the Fund received no income from the security because LIBOR was always below 8.5 percent. And because LIBOR was still far below 8.5 percent in mid-1994, the Fund sold the interest-rate cap for somewhat less than half of its mid-1991 purchase price of $455,000.

This completes the chronology of Portfolio events. The next section presents the Portfolio loss analysis, which calculates the actual losses on the Portfolio securities. Following the loss analysis, I present the quantitative risk analysis, which shows that the post-1991 Portfolio was imprudently risky and that this risk was the cause of the losses.

3 Findings of Portfolio Loss Analysis

The loss analysis uses basic financial data on the securities bought and sold for the Portfolio during the 1988–1994 period during which the Trustees had dealings with Hassenmiller. These data, which are drawn from a Department of Labor (1996) memorandum, include for each of 78 securities: an identifying name, the buy date, the buy price measured as the total number of dollars spent to purchase the security, the dollar amount of interest payments received, the dollar amount of principal payments received, the sell date, and the sell price measured as the total number of dollars received from the sale of the security. Only these basic data from the memorandum are used in the loss analysis; I made no use of the other information contained in the memorandum. These data are contained in Table 2 in Exhibit C, which begins on page 45.

The method of calculating the loss on a security involves comparing the actual return, which is the dollar return received during each security's holding period (*i.e.*, the time between its buy date and sell date), with the opportunity return, which is the dollar return that would have been received during the security's holding period if the buy price had been invested with the Fund's bond-and-stock investment managers. The second return measures the opportunity cost of using the funds to invest in the Portfolio. The opportunity return for each security is calculated using historical rates of return earned by the Fund's bond-and-stock investment managers, as described in Exhibit C.

The opportunity return minus the actual return is the dollar loss as of the security's sell date. This sell-date loss is then projected to September 30, 1995, using the appropriate historical rates of return earned by the Fund's bond-and-stock investment managers. It is this 9/30/95 loss that is shown for each of the Portfolio securities in Table 2.

The results of the loss analysis show that the Fund experienced losses on 23 of the 78 securities in the Portfolio. The total 9/30/95 loss for those 23 securities was $13,155,657. When historical rates of return earned by the Fund's bond-and-stock investment managers after September 30, 1995, are available, the total loss will be calculated for a more recent date. Assuming that historical rates of return have been positive since 9/30/95, the total loss for a more recent date will be larger than thirteen million dollars.

4 Findings of Portfolio Risk Analysis

This section of the report summarizes the risk-adjusted portfolio rate-of-return method and the data used in the risk analysis, and presents its major quantitative findings.

The risk analysis employs a method that is described in fixed-income and mortgage finance textbooks and is used by some of the largest and most sophisticated financial institutions.

This risk-adjusted portfolio rate-of-return method requires three kinds of data in addition to the basic financial data on Portfolio securities that I used in the loss analysis. These additional data include: (1) data on historically plausible expectations concerning interest rate movements, (2) data from a quantitative study of the sensitivity of Portfolio security holding-period rates of return to changes in interest rates, and (3) data from a study of the prudence of different degrees of risk aversion.

Details of both the method and additional data used in the risk analysis are contained in Exhibit D, which begins on page 50.

4.1 What Was the Nature of Portfolio's Risk?

As I explained in the discussion of the Portfolio's composition on pages 3–18, even though the interest and principal payments of the MBS underlying most of the Portfolio securities were insured by government-sponsored enterprises, there was no guarantee that an investor's purchase price would always be returned. In fact, as I explained above, when interest rates move higher or lower, the holding-period return of IO strips, PO strips, interest-rate caps, inverse floaters, and super POs, all change substantially. Given the extreme return sensitivity to changes in interest rates exhibited by these types of securities, historically plausible interest-rate movements could easily generate negative holding-period rates of return (*i.e.*, investment losses).

The focus of the Portfolio risk analysis is, therefore, interest-rate risk, not default or credit risk. It is common knowledge in the capital markets that despite the fact that government-sponsored enterprises provide effective MBS insurance against the credit risk associated with homeowner mortgage defaults, some mortgage securities derived from MBS — particularly strips and riskier CMO tranches (which definitely include inverse floaters and super POs) — exhibit substantial interest-rate risk.

4.2 How Is Interest-Rate Risk Measured?

The first thing to understand is that professional portfolio managers are concerned about the interest-rate risk of a portfolio. The interest-rate sensitivity of an individual security is of interest only because a portfolio's interest-rate sensitivity is a weighted average of the sensitivities of its constituent securities. When added to a portfolio, a security that is highly interest-rate sensitive might actually reduce the portfolio's interest-rate sensitivity if the added security's return was high when the portfolio's return was low and vice versa. But if the added security's return was high (low) at the same time the portfolio's return was high (low), its addition could increase the portfolio's sensitivity.

In the analysis of the Portfolio's interest-rate risk, I employ the risk-adjusted portfolio rate-of-return method. This method involves four stages of analysis.

First, expectations about the magnitude and likelihood of future interest rate movements are specified. As is customary, I conducted a statistical analysis of the history of interest-rate movements to specify future movement expectations.

Second, the sensitivity of a security's holding-period rate of return to movements in interest rates is determined quantitatively for each type of security held in the portfolio. This may involve use of an MBS or CMO simulation model or it may involve, as it does in this analysis, the use of historical data on actual Portfolio security returns experienced in different interest-rate environments to estimate an econometric model of return sensitivity.

Third, computer simulation methods are used to estimate the portfolio holding-period rates of return that would be realized under a number of anticipated interest-rate scenarios. The interest-rate scenarios are generated from the expectations concerning future rate movements that were specified in the first stage of risk analysis. The portfolio holding-period is typically set at several years; I use three years in this analysis. The quantitative return sensitivities determined in the second stage of the risk analysis are combined with each projected interest-rate scenario to produce a holding-period rate of return for each security under each anticipated scenario. The security-size-weighted average of the individual security rates of return constitutes the portfolio holding-period rate of return for each future interest-rate scenario. Since the first stage of the risk analysis specified the likelihood of each interest-rate scenario, the probability of the simulated portfolio holding-period rate of return for each scenario is also known.

And fourth, the magnitude and likelihood of the simulated portfolio holding-period rates of return are used to calculate a risk-adjusted portfolio rate of return. This risk-adjusted measure combines the average level of anticipated portfolio returns with the variability of those returns to produce a single risk-adjusted rate-of-return measure. A key part of the fourth stage of risk analysis is to specify the assumed degree of risk aversion used in the expected utility function that performs this combination of average return and return variability. The resulting risk-adjusted portfolio rate of return can then be compared to risk-adjusted rates of return available on other investments to determine whether the portfolio in question is a prudent investment.

I use two degrees of risk aversion in the Portfolio risk analysis. The lower of the two represents a *minimally prudent* degree of risk aversion, while the higher of the two represents what I consider an *appropriately prudent* degree of risk aversion for trustees of a pension fund. Exhibit D presents a study of the likelihood and magnitude of potential investment gains and losses relative to riskless investments in zero-coupon Treasury bonds. That study establishes borderlines between three ranges: low degrees of risk aversion that are imprudent from a relative loss perspective, middle degrees of risk aversion that are prudent from a relative loss perspective, and degrees of risk aversion that are so high that sensible investment opportunities are rejected. The degree of risk aversion that is located at the border of the low and middle ranges is the minimally prudent degree of risk aversion used in the Portfolio risk analysis. The appropriately prudent degree of risk aversion is in the center of the middle range, half way between the lower border and the upper border where excessively prudent degrees of risk aversion begin.

For methodological details and references to the professional finance literature, see Exhibit D beginning on page 50.

4.3 How High Was Portfolio's Interest-Rate Risk?

The risk-adjusted portfolio rate of return can be viewed as the average portfolio rate of return minus a portfolio risk factor. This risk factor depends on two things: (1) the variability of the anticipated portfolio rates of return around the average of those anticipated portfolio rates of return and (2) the assumed degree of aversion to that variability in anticipated portfolio rates of return.

The most common measure of return variability around the average rate of return is the variance statistic and its square root, which is called the standard deviation of the anticipated portfolio rates of return. If anticipated rates of return are certain (*i.e.*, have a zero standard deviation), then the portfolio risk factor is zero and the risk-adjusted rate of return equals the average rate or return. More commonly, anticipated portfolio rates of return vary around the average portfolio rate of return. In this case, the risk factor will be zero only if the assumed degree of risk aversion is zero, an attitude that is termed being risk neutral because there is no concern about how much anticipated returns may vary above or below the average. With a risk-averse attitude (*i.e.*, with a positive degree of risk aversion), the risk factor is positive whenever the standard deviation of the anticipated portfolio rates of return is greater than zero. A positive risk factor implies that the risk-adjusted rate of return is less than the average rate of return. The larger the standard deviation of the anticipated returns and/or the larger the assumed degree of risk aversion, the larger the risk factor, which implies that the risk-adjusted rate of return is further below the average rate of return.

Before presenting estimates of the risk-adjusted Portfolio rate of return, I use the results of the first three stages of the risk-analysis method to compute the standard deviation of the Portfolio's holding-period rates of return in the anticipated interest-rate scenarios. I calculate this measure of return variability for the Portfolio at several dates during the 1988–1993 period.

Figure 6 on the next page shows that the Portfolio's anticipated rate-of-return variability before 1991 was fairly stable, but that Portfolio return variability increased three-fold to four-fold following the post-1991 changes in composition described on pages 3–18. This sharp rise in the rate-of-return variability of the Portfolio was caused solely by changes in its composition because the same interest-rate expectations and return sensitivity estimates are used for each calculation date.

This quantitative measure of the Portfolio's anticipated rate-of-return variability confirms what was suggested by the qualitative discussion of the interest-rate sensitivity of the Portfolio's constituent securities on pages 3–18. The nature of the higher post-1991-Portfolio return variability was such that rising interest rates would cause losses and falling interest rates would cause gains. In other words, the Portfolio would avoid generating losses only if interest rates did not rise, which was a questionable bet at the end of 1993 when interest rates were at a twenty-year low (see Figure 3 on page 19).

Consider, for example, the Portfolio in mid-1993, when the variability

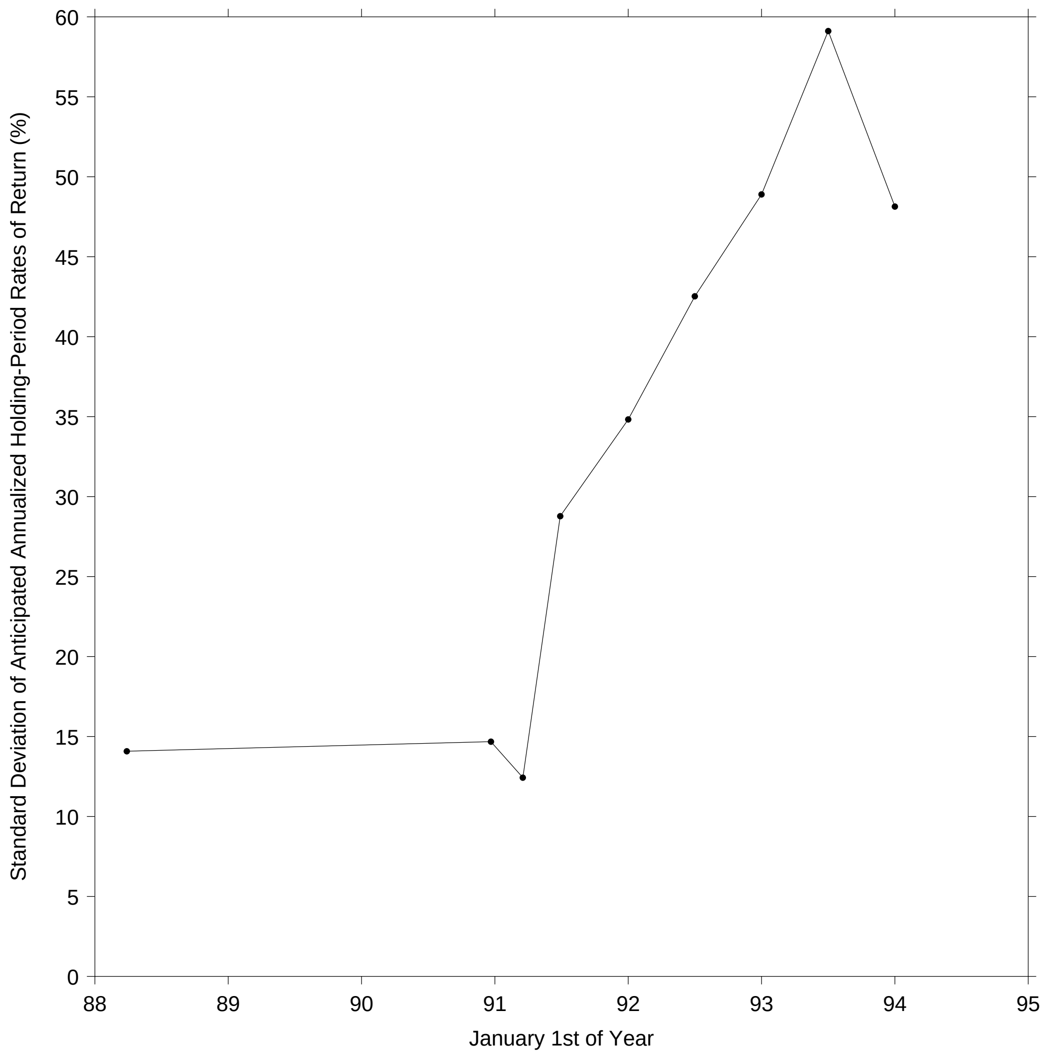

Figure 6: **Portfolio's Rate-of-Return Variability during 1988–1993 Period**. Variability measured by the standard deviation of portfolio holding-period rates of return that would be experienced under different anticipated interest rate scenarios.

of anticipated holding-period rates of return was at its maximum and just before interest rates began rising in late 1993 and 1994. In the scenario in which interest rates are projected to be two-percentage points higher at the end of the three-year holding period, the anticipated Portfolio holding-period annualized rate of return is estimated to be about –45 percent. Compounding that annual rate of return over three years produces a three-year rate of return of about –83 percent, which means only seventeen cents on the dollar of original investment is left after three years. On the other hand, in the scenario in which interest rates are projected to be two-percentage points lower at the end of the three-year holding period, the anticipated Portfolio holding-period rate of return is high, indicating sizable gains. But these gains would be short-lived because of the fast prepayment of the inverse superfloater companion CMO tranches that were heavily represented in the Portfolio at that time.

4.4 How Low Was Portfolio's Risk-Adjusted Return?

How did the higher level of anticipated return variability exhibited by the Portfolio after the 1991 changes in composition affect the risk-adjusted Portfolio rate of return? I present two answers to this question: one answer is derived from assuming the minimally prudent degree of risk aversion in the fourth stage of the risk analysis, while the other answer is derived from assuming the appropriately prudent degree of risk aversion in the calculation of risk-adjusted Portfolio rates of return.

Both Figure 7 on page 31 and Figure 8 on page 32 show that the risk-adjusted Portfolio rate of return fell sharply after the 1991 changes in the Portfolio's composition. Again, it is important to stress that this change reflects the changing composition of the Portfolio and the resulting increase in the variability of anticipated rates of return, not changes in the assumptions used in the risk analysis (which are constant over the whole period) and not changes in the Portfolio's actual interest-rate environment (because the risk analysis uses the same expectations about future interest-rate movements over the whole period). The only significant difference between the pattern of results generated by the two degrees of risk aversion, is that the risk-adjusted Portfolio rate of return falls to a lower level under the appropriately prudent degree of risk aversion. This difference is caused by the fact that the higher degree of risk aversion places more weight on the variability of the anticipated returns than does the lower minimally prudent level. This higher weighting implies a bigger risk factor, which when subtracted from the average return produces a lower risk-adjusted return.

4.5 What Risk-Adjusted Returns Were Available?

The Portfolio risk analysis shows that after the 1991 changes in the composition of the Portfolio, the variability of the Portfolio's anticipated rates of return rose sharply to much higher levels than for the pre-1991 Portfolio. The Portfolio's risk-adjusted rate of return fell sharply at the same time because the Portfolio's average anticipated rate of return did not rise enough to offset the higher return variability.

Did this fall in the Portfolio's risk-adjusted rate of return indicate imprudence? The answer to that question depends on the risk-adjusted rates of return on other investment opportunities available to the Fund. If the Fund could have used the money invested in the Portfolio to invest in some other kind of portfolio that had a higher risk-adjusted rate of return, then this alternative portfolio would provide a better investment for the Plan's participants. Because the portfolios are being compared using risk-adjusted returns, not only is it possible to rank the investment desirability of alternative portfolios, but this ranking method is common among institutional investors (Holmer 1994, for the example of Fannie Mae). The basic principle of portfolio management is to avoid portfolios that have lower risk-adjusted rates of return than do other available portfolios. In other words, include the kind and amount of securities in the portfolio that produces the highest possible risk-adjusted anticipated portfolio rate of return.

Given my portfolio-management knowledge and experience, if the risk-adjusted anticipated rates of return on alternative portfolios were substantially above that of the post-1991 Portfolio, then the post-1991 Portfolio was an imprudent investment, regardless of whether it produced actual gains or actual losses. If the post-1991 Portfolio's risk-adjusted anticipated rate of return was not substantially below others available in the capital markets, then despite its riskiness, the post-1991 Portfolio was a prudent investment that simply turned out to produce a loss in 1994.

Exhibit D describes a study that estimates the risk-adjusted rate of return for a portfolio that is a fifty-fifty mix of long-term Treasury bonds and the S&P 500 stock index. This is close to the portfolio composition provided by the Fund's bond-and-stock investment managers (Wright Investors and Weiss, Peck & Greer), who provided the most obvious alternative invest-

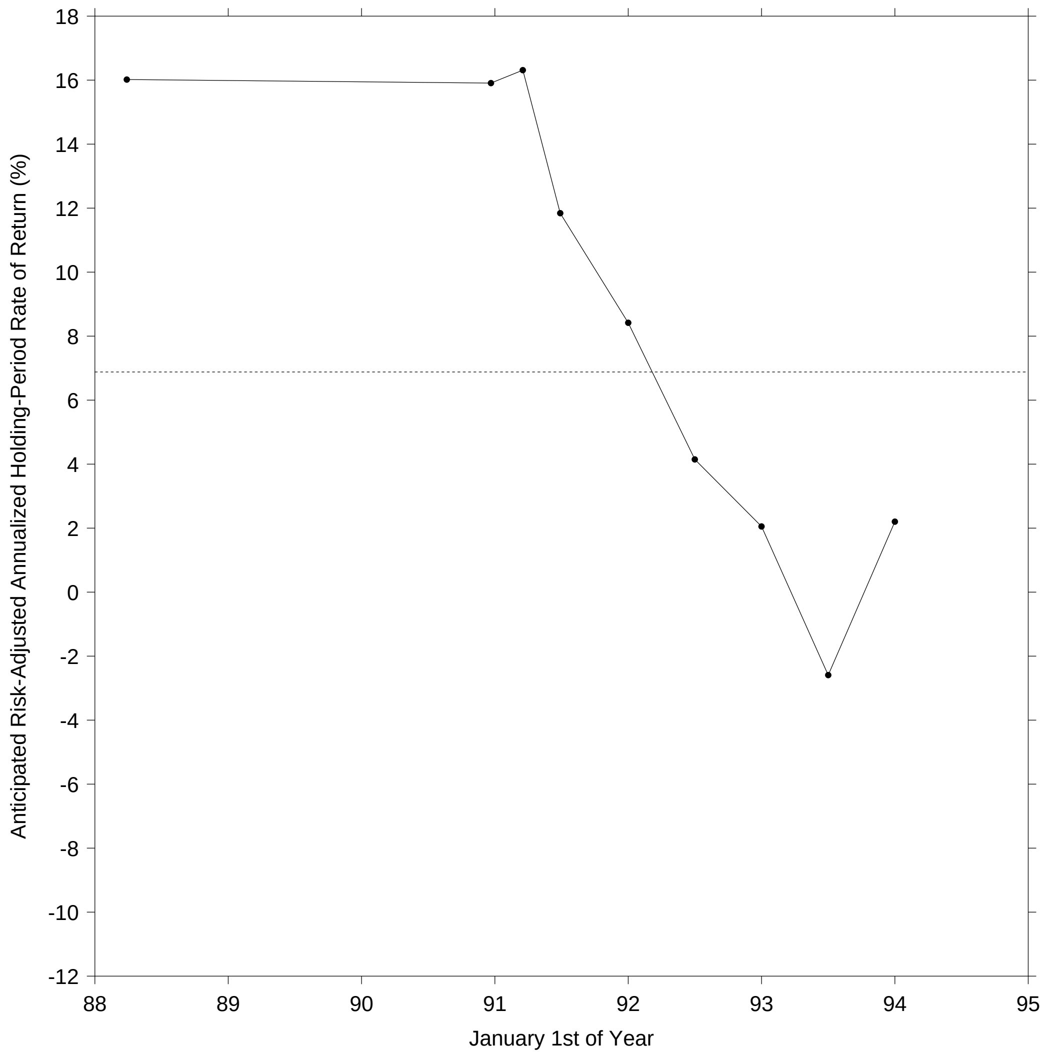

Figure 7: **Risk-Adjusted Rate of Return on Portfolio during 1988–1993 Period, Assuming *Minimally* Prudent Aversion to Risk**. The dashed line represents the risk-adjusted anticipated rate of return on a portfolio that contains half long-term Treasury bonds and half S&P 500 stocks.

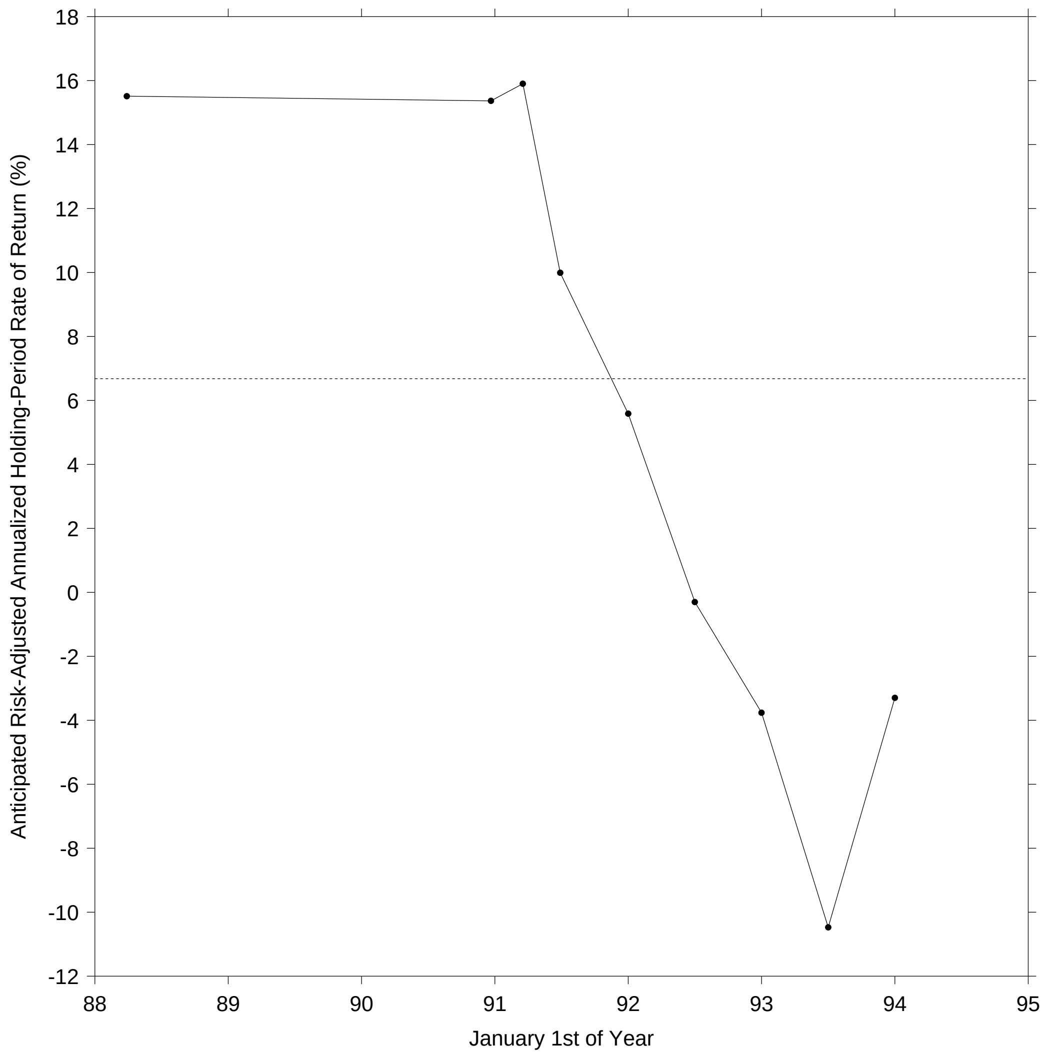

Figure 8: **Risk-Adjusted Rate of Return on Portfolio during 1988–1993 Period, Assuming *Appropriately* Prudent Aversion to Risk**. The dashed line represents the risk-adjusted anticipated rate of return on a portfolio that contains half long-term Treasury bonds and half S&P 500 stocks.

ment for the money invested in the Portfolio. Using historically plausible expectations about bond and stock returns, I find that the risk-adjusted anticipated rate of return on this alternative portfolio is between six and seven percent depending on which of the two degrees of risk aversion is assumed.

The horizontal dotted line in Figure 7 on page 31 and in Figure 8 on the page before indicate the level of the risk-adjusted anticipated bond-and-stock rate of return. In both cases, the risk-adjusted Portfolio rate of return had fallen below the risk-adjusted bond-and-stock rate of return by early 1992. And in both cases, the Portfolio's risk-adjusted rate of return eventually fell far below that on this alternative bond-and-stock portfolio.

5 Conclusions

My conclusions are based on the findings of the Portfolio loss and risk analyses described above, on my reading of two depositions taken pursuant to the Complaint (Hassenmiller 1997, Krzywicki 1997), and on my perusal of a large number of documents provided to me by the Department of Labor.

5.1 Evidence of Procedural Imprudence

I conclude that, even if the Portfolio had never experienced any losses, the manner in which the Portfolio was managed was imprudent. This conclusion is based on the facts of how the Portfolio was managed and on my experience of what kinds of portfolio management techniques are required when investing in interest-rate caps, MBS strips, inverse floaters, and super-POs.

Both Hassenmiller (1997) and Krzywicki (1997) confirm that a security's prospectus was not examined before it was purchased for the Portfolio and that there was no use of a computer simulation model to estimate anticipated rates of return on the Portfolio under different future interest-rate scenarios. In my opinion, both are required for prudent portfolio management when interest-rate-sensitive mortgage derivatives and interest-rate caps are being considered for inclusion in a portfolio.

5.2 Imprudent Risk as Cause of Portfolio Loss

I conclude that the post-1991 Portfolio was imprudently risky because its risk-adjusted anticipated rate of return was substantially below that available from investments similar to those made by the Fund's bond-and-stock investment managers and even below the interest-rate-risk-free rates of return available from investments in zero-coupon Treasury bonds. I also conclude that the nature of the Portfolio's interest-rate risk was the cause of the Portfolio losses, which are calculated to be $13,155,657 as of September 30, 1995.

Martin R. Holmer Date
Policy Simulation Group

A Expert's Qualifications and Résumé

Mr. Holmer earned a Ph.D. in mathematical and financial economics at the Massachusetts Institute of Technology. Following an economic research career in the federal government, Mr. Holmer began a career in asset-liability management with a special emphasis on mortgage-backed securities.

As vice-president for mortgage securitization at E.F. Hutton during 1986 and 1987, he developed the computer software necessary for Hutton to enter the collateralized mortgage obligation (CMO) business. The software simulated the financial mechanics of any specified CMO, thereby enabling Hutton to design a CMO's structure, produce information required to obtain an S&P rating, produce required prospectus information, and produce pricing and financial performance information used in marketing the CMO.

While at Fannie Mae from 1987 to 1992, Mr. Holmer created the system used to manage the retained mortgage portfolio, a very large collection of mortgage assets (over $291 billion) that are mostly debt financed (OFHEO 1997, p. 42). The high degree of financial leverage in this portfolio requires careful interest-rate risk management to ensure profitability in a wide range of future interest-rate environments. His work at Fannie Mae involved the development and computer implementation of an asset-liability management system that used computer simulation of uncertain future financial environments to provide the information necessary to optimize the asset and debt composition of the portfolio to obtain the the desirable combination of expected profitability and risk (Holmer 1994).

After leaving Fannie Mae, Mr. Holmer was a lecturer and research associate at the Wharton School of the University of Pennsylvania during 1992 and 1993. His research there focused on advanced methods of optimizing portfolios whose value is sensitive to interest-rate changes and on practical methods of implementing asset-liability management techniques in financial institutions (McKendall, Zenios, and Holmer 1994, Holmer and Zenios 1995, Golub, etal. 1995, Holmer forthcoming, for example).

Mr. Holmer's current consulting practice at the Policy Simulation Group includes several engagements with foreign mortgage-finance institutions that focus on asset-liability and risk management issues, as well as participation in several World Bank housing finance missions to the Philippines. He was also selected by the Social Security Administration to perform quantitative risk analysis of the implications of investing trust funds in equities (Holmer and Bender 1996).

Résumé of Martin R. Holmer

Professional Experience

1996–	Policy Simulation Group, Inc. President
1992–96	HR&A (Hamilton, Rabinovitz & Alschuler, Inc.) Principal and Head of HR&A Policy Simulation Group
1992–93	Wharton School, University of Pennsylvania Research Associate and Lecturer
1987–92	Federal National Mortgage Association (Fannie Mae) Vice President for Asset/Liability Strategy
1986–87	E.F. Hutton & Company Vice President for Mortgage Securitization
1984–86	U.S. Department of Health and Human Services Senior Economic Advisor to Deputy Assistant Secretary for Health Policy
1980–84	U.S. Department of Health and Human Services Director of Income Security Policy Research
1974–80	U.S. Department of Health and Human Services Senior Economist, Income Security Policy Research Office
1969–74	Emmanuel College, Boston, Massachusetts Instructor, Department of Economics

Educational Background

1975 Ph.D., Economics, Massachusetts Institute of Technology

Major: Mathematical Economics

Minors: Monetary Economics, Public Economics, Econometrics, International Economics

Honors: Woodrow Wilson Fellowship, U.S. Department of Labor Manpower Dissertation Fellowship

1967 B.A., Mathematics and Economics, University of Kansas

Honors: Phi Beta Kappa, Degree with Honors in Economics

Selected Technical and Managerial Capabilities

Stochastic Simulation Modeling of Social Security
Developed for 1994–95 Social Security Advisory Council's Technical Panel on Assumptions and Methods (working with Social Security and Medicare actuaries) a conceptual framework and partial implementation of a long-run stochastic simulation model that provides quantitative estimates of the uncertainty facing the OASDI programs. Completed development of the simulation model under a competitively-awarded contract from the Social Security Administration and used the model to analyze for the Advisory Council the expected return and risk effects of policies that invest a fraction of OASI trust funds in equities rather than the customary special-issue Treasury bonds. Under a subsequent series of contracts from the Employee Benefit Research Institute, the model has been extended to include lifetime cohort measures such as money's worth rate of return, individual account reform analysis capabilities, and an embedded neoclassical economic growth model with links to the broader Social Security model.

Asset-Liability Management Policy Analysis
Developed for World Bank and a government-sponsored housing-finance and provident-saving agency in the Philippines an assessment of current financial projection capabilities and plans for developing an enhanced model for assessing alternative asset-liability management policies. Developed for Fannie Mae a risk-based capital-adequacy model for use in assessing an existing government-sponsored mortgage insurance agency in the Philippines. Participated with World Bank and Fannie Mae staff in the planning for a secondary mortgage-market corporation in the Philippines.

Stochastic Simulation Modeling of Private Health Insurance Markets
Developed for RAND (as part of the Robert Wood Johnson Foundation's State Initiatives Program) a conceptual framework and computer implementation of a stochastic simulation model of health insurance market dynamics. The model provides the capability for analyzing market-oriented reforms by explicitly representing the uncertainty facing plans, establishments, and families as they make private health insurance decisions from year to year.

Stochastic Simulation Modeling of Private Pensions
Developed for Pension Benefit Guaranty Corporation (PBGC) a conceptual framework for estimating the present value of expected PBGC claims and pre-

mium income under alternative economic, actuarial, and policy assumptions. The conceptual framework has been implemented as a stochastic simulation model — the Pension Insurance Management System (PIMS) — that combines economic modeling of the incidence of corporate bankruptcy, actuarial modeling of pension obligations that recognizes moral hazard effects, and financial modeling of the effects of fluctuations in interest rates on corporate debt and pension assets and liabilities. PIMS is being used to support both policy analysis and accrual budgeting activities at PBGC.

Portfolio Optimization Modeling
Designed and implemented for Fannie Mae a portfolio optimization system to support asset-liability management of a large, highly-leveraged portfolio of mortgage securities. The Asset/Liability Management Strategy (ALMS) System combines binomial lattice and options-based methods to estimate security prices and holding-period returns with expected utility maximization methods to optimize portfolio composition. The ALMS System handles portfolios containing a variety of mortgage securities as well as non-callable and callable bonds, interest-rate swaps, caps and floors, and bond options. The System is implemented as a suite of client/server applications using Sybase relational database tools on a network of forty Unix workstations. This distributed implementation permits parallel processing of financial calculations with a virtually linear speed-up that reaches supercomputer throughput levels using only a dozen workstations. The ALMS System has been used to justify to top management and then shareholders an increased reliance on callable debt (from zero to forty percent in a few years) as a strategy for increasing the risk-adjusted return on equity. It has also been used to design and test portfolio hedging transactions.

Research Management
Experience managing staffs of technical professionals conducting intramural research as well as the design and execution of an extramural research program. This experience, which has been gained in both the public and private sectors, includes: developing, defending, and conducting federal government research programs; initiating and completing large corporate projects; and building from scratch a consulting practice consisting of domestic and international clients in both the public and private sectors.

Software Development
Extensive experience with both doing and managing the development of com-

plex computer programs in Unix as well as PC environments. Designed and implemented an innovative distributed application using client/server techniques on a network of Unix workstations that operates in a large corporate computing environment. Extensive experience with object-oriented design of simulation programs that are implemented in the C++ language.

Relational Database Modeling
Designed and implemented numerous relational database systems using both Unix and PC relational database management systems.

Cross-Section Econometric Estimation
Designed, estimated, developed, and utilized for U.S. Department of Health and Human Services a health insurance and services demand simulation model to assess the government cost and economic impact of alternative policies in the area of tax treatment of employer-sponsored health insurance. The model consists of two modules: a health-insurance demand model based on econometric estimates using a cross-section of experimental plan choice data and a health-services demand model based on econometric estimates of cross-section data on utilization and cost from the RAND Health Insurance Experiment. The model provides estimates of how a change in tax policy or available health insurance plans alters patterns of plan choice and services utilization in the population. It also produces estimates of health insurance plan premiums that are superior to conventional actuarial estimates because they recognize adverse selection and moral hazard effects. The model was used extensively to prepare the HHS Secretary's report to Congress on cafeteria plans and flexible spending accounts, and a mainframe variant has been used subsequently by RAND in various health policy research projects.

Times-Series Econometric Estimation
Designed and estimated for U.S. Social Security Administration a macroeconomic vector-autoregressive (VAR) model of cyclical fluctuations in interest, inflation, and unemployment rates, which is embedded in a long-run, stochastic policy simulation model of the OASI and DI programs. Designed and estimated for U.S. Department of Health and Human Services a multiple-equation quarterly time-series model to predict national AFDC program recipients and benefit costs as a function of economic conditions, demographic trends, and the nature of program policy. A state-specific variant of the forecasting model was used for annual budget projections by departmental

staff.

Regional Input-Output Modeling
Developed for U.S. Department of Health and Human Services an economic simulation system that integrates a tax-transfer microeconomic simulation model of the household sector (based on Census sample survey data) with a multiregional input-output model of the business sector to provide estimates of the direct and indirect economic effects of changes in tax, income-transfer, or expenditure policy. A grant to Boston College supported further development of the integrated system, which was subsequently used by the Joint Economic Committee of the U.S. Congress, and which led to an offer by Data Resources, Inc. (DRI) to buy the system from Boston College.

Selected Articles and Reports

"Integrated Asset-Liability Management: An Implementation Case Study," in William T. Ziemba and John M. Mulvey (editors), *World Wide Asset and Liability Modeling*, Cambridge University Press, forthcoming.

"Stochastic Simulation of Economic Growth Effects of Social Security Reform," in Olivia S. Mitchell (editor), *Prospects for Social Security Reform*, Philadelphia: University of Pennsylvania Press for the Pension Research Council, forthcoming.

"EBRI Social Security Reform Analysis Project Progress Report: Phases 1 and 2," in Dallas L. Salisbury (editor), *Assessing Social Security Reform Alternatives*, Washington, DC: Employee Benefit Research Institute, 1997, pp. 43–56.

"Alternative Models of Choice Under Uncertainty and Demand for Health Insurance," with Susan Marquis, *Review of Economics and Statistics*, August 1996, *78*(3), pp. 421–427.

"Demographic Results from SSASIM, a Long-Run Stochastic Simulation Model of Social Security," in Report of the Technical Panel on Assumptions and Methods, in *Report of the 1994-1995 Advisory Council on Social Security, Volume II*, Washington, DC: U.S. Government Printing Office, 1996, Appendix A, pp. 183–222.

"Stochastic Simulation of Trust Fund Asset Allocation," with Christopher

Bender in *Report of the 1994-1995 Advisory Council on Social Security, Volume II*, Washington, DC: U.S. Government Printing Office, 1996, pp. 431–450.

"The Productivity of Financial Intermediation and the Technology of Financial Product Management" with Stavros Zenios, *Operations Research*, November-December 1995, *43*(6), pp. 970–982.

"A Stochastic Programming Model for Money Management" with B. Golub, et al., *European Journal of Operational Research*, September 1995, *85*(2), pp. 282–296.

"The Effects of Small Group Reform on Employers' Decisions to Offer Health Insurance: Some Preliminary Results" with Stephen Long and Susan Marquis, paper presented at American Economics Association meetings, Washington, DC, January 7, 1995.

"The Asset/Liability Management Strategy System at Fannie Mae," *Interfaces*, May-June 1994, *24*(3), pp. 3–21.

"Stochastic-Programming Models for Portfolio Optimization of Mortgage-Backed Securities: A Comprehensive Research Guide" with Raymond McKendall and Stavros Zenios in R.L. D'Ecclesia and S.A. Zenios (editors), *Operations Research Models in Quantitative Finance, Contributions to Management Science*, Springer-Verlag, 1994.

"Variance Reduction in Corporate Bankruptcy Simulation," paper presented at joint Institute of Management Science and Operations Research Society meetings, Phoenix, AZ, November 1, 1993.

"Designing Callable Bonds using Simulated Annealing" with Dafeng Yang and Stavros Zenios, Wharton Decision Sciences Report 93-07-02, July 1993.

"Simulating Health Expenditures Under Alternative Insurance Plans" with Joan Buchanan, Emmett Keeler, and John Rolph, *Management Science*, September 1991, *37*(9), pp. 1067–1090.

"Tax Policy Toward Health Insurance and the Demand for Medical Services" with Howard Chernick and Daniel Weinberg, *Journal of Health Economics*, March 1987, *6*(1), pp. 1–25.

"Choice Under Uncertainty and the Demand for Health Insurance" with Susan Marquis, RAND Corporation N-2516-HHS, September 1986.

"A Federal Case Against Flexible Spending Accounts" with Stuart Schmid, *Business and Health*, March 1986.

"A Study of Cafeteria Plans and Flexible Spending Accounts" with Stuart Schmid, *Commerce Clearing House*, August 1985. (reprint of a DHHS study report mandated by Congress).

"Structure, Precision and Validity of a Health Insurance and Services Demand Model," Technical Appendix to DHHS *A Study of Cafeteria Plans and Flexible Spending Accounts*, April 1985.

"Tax Policy and the Demand for Health Insurance," *Journal of Health Economics*, December 1984.

"A Microeconomic Simulation Model for Analyzing the Regional and Distributional Effects of Tax-Transfer Policy: An Analysis of the Program for Better Jobs and Income" with Robert Haveman, Kevin Hollenbeck, and David Betson, in Haveman and Hollenbeck (editors), *Microeconomic Simulation Models for Public Policy Analysis, Volume 2: Sectoral, Regional, and General Equilibrium Models*, New York: Academic Press, 1980.

"Urban, Regional and Labor Supply Effects of a Reduction in Federal Income Tax Rates" in Norman Glickman (editor), *The Urban Impacts of Federal Policy*, Baltimore: Johns Hopkins University Press, 1980.

"The Urban and Regional Impact of the Carter Administration's 1979 Welfare Reform Proposal" with Howard Chernick, DHHS working paper, June 1979.

"Preliminary Analysis of the Regional Economic Effects of Federal Procurement," DHHS working paper presented at Committee on Urban Public Economics meetings, June 1977.

"Why Have Transfer Programs Grown So Rapidly?," DHHS working paper presented at Committee on Urban Public Economics meetings, October 1976.

"Reasons for the Growth in the Food Stamp Program," DHHS working paper presented at Western Economics Association meetings, June 1976.

"Aid to Families with Dependent Children" in "The Cyclical Behavior of Income Transfer Programs: A Case Study of the Current Recession," Technical Analysis Paper No. 7, DHHS Office of Income Security Policy, October 1975.

"Preliminary Report on a U.S. AFDC Forecasting Model," DHHS working paper, August 1975.

"The Economic and Political Causes of the 'Welfare Crisis'," Ph.D. dissertation, Massachusetts Institute of Technology, June 1975.

B Expert's Compensation and Prior Cases

This exhibit contains information about the rate of compensation for expert research and testimony on this case as well as information regarding prior cases in which the expert has testified.

B.1 Compensation for Study and Testimony

The Policy Simulation Group, Inc., is charging the U.S. Department of Labor $250 per hour for all work performed by Mr. Holmer on this case. This hourly rate does not include certain approved non-labor costs related to data acquisition, travel, reproduction, delivery, etc., which are billed at cost as incurred.

B.2 Expert Testimony in Prior Cases

Mr. Holmer has not testified as an expert in any other court cases.

C Expert's Detailed Portfolio Loss Analysis

In this Exhibit, I describe details of my loss analysis, the findings of which I present in Section 3.

The basic financial data on the 78 Portfolio securities that I use in the loss analysis, which are drawn from a Department of Labor (1996) memorandum, are contained in Table 2 on pages 47–50. The "HP Years" column of that table contains the length of the security's holding period (the period between the buy date and sell date) measured in years. The "9/30/95 Loss" column contains the dollar loss on each security.

The method I employ to calculate the losses has been described above on page 23. This method requires the use of historical rates of return earned by the Fund's bond-and-stock investment managers. The data I use to calculate these opportunity returns are shown in Table 1.

Table 1: **Rates of Returned Earned by Fund's Bond-and-Stock Investment Managers, 1988–1995**. Rates of return are expressed in annualized percentage terms. The rate-of-return data in Table 5 are supplemented with data from Table 9 on the implied relative size of the portfolios handled by the two bond-and-stock investment managers. The tables mentioned as data sources are drawn from (Schloss 1997).

Time Period	**Rate of Return**	**Data Source**
full year ending 12/31/88	7.6%	Table 9
full year ending 12/31/89	23.1%	Table 5
full year ending 3/31/90	16.4%	Table 6
full year ending 3/31/91	13.0%	Table 6
full year ending 3/31/92	14.6%	Table 6
full year ending 3/31/93	12.3%	Table 6
full year ending 3/31/94	3.4%	Table 6
full year ending 3/31/95	2.5%	Table 6
half year ending 9/30/95	13.5%	Table 6

The method I use to calculate each Portfolio security's actual return assumes that all the interest and principal payments received during the security's holding period are received on the buy date and that those interest and principal payments earn reinvestment income until the sell date at the opportunity rate of return. These two assumptions are required because I have access only to the total amount of interest and principal payments received, not to data on the amount of interest and principal payments received each month during the holding period. These two assumptions concerning the timing and reinvestment of interest and principal payments are both biased in the direction of producing an underestimate of the true loss on a security. This is because interest and principal payments are never received on a security's buy date, but are usually spread out over its holding period. Also, the assumption that the interest and principal payments were reinvested at the rates of return shown in Table 1 on the page before is not realistic given the Trustees' and Hassenmiller's repeated statements that the Portfolio's monthly interest and principal payments were meant to pay Plan benefits. My intentional use of these two biased analytical assumptions makes my loss calculations quite conservative and highly defensible.

Table 2: **Portfolio Securities Data and Losses as of 9/30/95**.

(negative loss amounts represent dollar gains)

ID	Security	Buy Date	Buy Price	Interest	Principal	Sell Date	Sell Price	HP Years	9/30/95 Loss
1	FHLMC 160094	3/24/88	1,600,000	544,559	728,192	5/13/92	728,143	4.14	-212,543
2	CMO 29 PO	3/25/88	1,088,910	-	745,804	6/29/92	402,447	4.26	266,100
3	FHLMC 250291	11/20/90	1,212,018	-	526,853	5/13/92	678,653	1.48	204,406
4	GNMA 1 PO	11/20/90	1,086,853	-	604,129	6/29/92	773,431	1.61	-234,302
5	FHLMC 250291	12/20/90	227,491	-	100,928	5/13/92	127,380	1.40	33,018
6	FHLMC 503535	3/14/91	685,869	66,534	267,435	5/13/92	376,321	1.16	46,642
7	FNMA TR 74 IO	3/25/91	776,175	337,765	-	4/8/94	151,834	3.04	503,917
8	10yr 8.5% Libor Cap	6/14/91	455,000	-	-	6/3/94	220,500	2.97	429,895
9	FHLMC 1088 L IF	6/28/91	2,032,576	181,508	-	1/17/92	2,329,169	0.55	-461,665
10	FNMA 1989-3C SPO	11/26/91	4,783,143	-	-	11/26/91	5,040,697	0.00	-364,781
11	FNMA 1991-103 O	11/26/91	5,009,096	-	649,681	12/27/91	4,484,795	0.09	-104,484
12	FNMA TR 71 IO	11/26/91	7,262,540	2,265,830	-	4/8/94	1,421,745	2.37	5,423,419
13	FHLMC 1185 PO	12/30/91	5,002,000	-	-	12/30/91	5,063,000	0.00	-85,306
14	FNMA G19 S IF	12/30/91	5,145,697	175,008	-	1/17/92	5,250,238	0.05	-341,760
15	FNMA 91-147 SA IF	1/17/92	1,004,558	42,975	109,905	6/12/92	874,129	0.40	28,991
16	FHLMC 1076 N IF	1/17/92	2,276,863	164,975	635,800	6/18/92	1,567,732	0.42	-15,432
17	FNMA ??-41 SA IF	1/17/92	4,390,520	416,000	547,918	7/17/92	3,874,923	0.50	-299,408
18	FNMA 90-70 D SPO	5/29/92	2,223,780	-	2,404,086	8/20/92	-	0.23	-239,111
19	FNMA 92-49 SA IF	6/12/92	955,156	-	-	6/30/92	968,398	0.05	-10,190
20	FNMA 92-50 SB IF	6/18/92	1,946,969	25,068	-	7/15/92	2,046,037	0.08	-140,542
21	PaineWebber NF SPO	6/29/92	1,810,341	-	178,530	8/31/92	1,704,003	0.17	-50,441
22	FNMA 92-110 SA IF	7/30/92	1,978,077	-	-	7/30/92	1,998,077	0.00	-26,005
23	FNMA 92-36 SA IF	7/30/92	1,142,944	-	-	7/30/92	1,153,444	0.00	-13,653
24	FNMA 92-50 SB IF	7/30/92	1,138,550	-	-	7/30/92	1,201,925	0.00	-82,404
25	FHLMC 1311 T IF	7/30/92	2,065,060	-	-	8/6/92	2,116,089	0.02	-60,237
26	FHLMC 1301 KB IF	7/30/92	1,859,187	-	-	8/17/92	1,854,588	0.05	19,736

table continued on next page

Portfolio Securities Data and Losses as of 9/30/95.
(negative loss amounts represent dollar gains)

continued from previous page

ID	Security	Buy Date	Buy Price	Interest	Principal	Sell Date	Sell Price	HP Years	9/30/95 Loss
27	FNMA 92-79 SJ IF	7/30/92	1,491,566	22,339	-	8/27/92	1,500,756	0.08	-23,708
28	FHLMC 1265 OB IF	8/7/92	2,887,157	-	-	8/31/92	2,877,431	0.07	40,972
29	FHLMC 1177 W IF	8/7/92	530,243	63,794	-	2/3/93	530,218	0.49	-44,470
30	FNMA 92-149 S IF	8/28/92	2,082,661	-	-	8/28/92	2,108,661	0.00	-33,497
31	FNMA 92-49 J SPO	8/28/92	2,040,000	-	-	8/28/92	2,085,000	0.00	-57,975
32	FHLMC 1263 M PO	8/28/92	1,827,210	-	-	9/15/92	1,874,670	0.05	-47,367
33	FNMA 92-89 SD IF	8/28/92	1,077,568	133,268	64,303	4/8/93	965,209	0.61	-26,798
34	FNMA 92-35 IF	8/31/92	1,024,416	85,118	102,109	4/8/93	909,214	0.61	-15,651
35	FNMA 92-166 S IF	9/30/92	4,297,667	-	-	9/30/92	4,314,456	0.00	-21,404
36	FNMA 92-163 ? IF	9/30/92	1,238,005	15,028	35,601	2/26/93	1,222,872	0.41	26,853
37	FNMA 92-58 G PO	10/30/92	4,380,000	-	-	3/15/93	4,500,000	0.38	88,852
38	FNMA 92-58 H SPO	10/30/92	3,222,469	-	669,168	3/15/93	2,584,901	0.38	98,179
39	FNMA 92-201 SB IF	11/30/92	2,442,016	49,752	-	1/14/93	2,439,480	0.12	-15,724
40	FHLMC 1424 SA IF	11/30/92	2,165,116	51,103	100,912	2/8/93	2,142,072	0.19	-102,336
41	FNMA 92-68 E PO	12/30/92	1,087,500	-	85,316	1/28/93	1,036,257	0.08	-30,426
42	FNMA 90-130 J PO	2/4/93	1,600,000	-	-	2/12/93	1,613,750	0.02	-11,819
43	FNMA 93-9 SA IF	2/22/93	2,140,654	-	-	2/22/93	2,171,944	0.00	-38,095
44	FHLMC 1289 SD IF	2/26/93	2,043,521	30,056	-	3/15/93	2,060,000	0.05	-43,086
45	FNMA 92-180 S IF	3/11/93	1,158,184	225,301	-	4/8/94	814,234	1.08	182,649
46	FNMA 93-G4 (or-4 G)	3/15/93	2,675,000	-	-	3/15/93	2,725,000	0.00	-60,469
47	FNMA 93-23 SD	3/30/93	5,062,729	-	-	3/30/93	5,112,729	0.00	-60,181
48	FNMA 93-28 SC	3/30/93	2,872,310	-	-	3/30/93	2,904,249	0.00	-38,443
49	FNMA 93-29 SA IF	3/30/93	4,075,820	47,400	-	4/27/93	4,102,306	0.08	-75,169
50	FNMA 93-29 SP IF	3/30/93	802,006	12,032	-	5/12/93	814,769	0.12	-25,768
51	FNMA 93-8 G	3/31/93	1,962,750	-	-	3/31/93	1,982,750	0.00	-24,065
52	FNMA 93-23	3/31/93	1,960,553	-	-	3/31/93	1,980,953	0.00	-24,546

table continued on next page

Portfolio Securities Data and Losses as of 9/30/95.
(negative loss amounts represent dollar gains)

continued from previous page

ID	Security	Buy Date	Buy Price	Interest	Principal	Sell Date	Sell Price	HP Years	9/30/95 Loss
53	FNMA 93-46 SD IF	4/30/93	2,339,220	-	-	4/30/93	2,352,872	0.00	-16,382
54	FNMA 93-51 D SPO	4/30/93	2,430,000	-	-	4/30/93	2,460,000	0.00	-35,998
55	FHLMC 1491 IF	4/30/93	2,517,110	-	-	5/12/93	2,543,297	0.03	-28,070
56	FNMA 93-46 SG IF	4/30/93	1,944,213	72,320	-	7/21/93	1,970,000	0.23	-100,033
57	FHLMC G5 SB IF	4/30/93	1,840,059	165,341	-	10/19/93	1,842,750	0.47	-167,063
58	FHLMC 1491 Q IF	4/30/93	2,511,788	246,347	457,407	12/30/93	2,016,148	0.67	-196,251
59	FNMA 93-39 SA IF	4/30/93	954,051	105,105	881,366	5/6/94	125,339	1.02	-184,401
60	FNMA 92-56 E SPO	5/28/93	3,882,250	-	-	5/28/93	3,935,250	0.00	-63,434
61	FHLMC 1534 PG	6/30/93	748,260	-	-	6/30/93	755,760	0.00	-8,949
62	FHLMC 1533 SB	6/30/93	4,088,382	6,355	-	7/20/93	4,058,927	0.06	36,429
63	FNMA 93-110 S	7/30/93	757,740	-	-	7/30/93	766,490	0.00	-10,412
64	FHLMC 1552 QH IF	8/30/93	3,797,447	-	-	8/30/93	3,825,571	0.00	-33,372
65	FHLMC 1560 SL IF	8/30/93	2,080,000	50,556	-	10/22/93	2,100,000	0.14	-71,654
66	FHLMC 1552 QB IF	8/30/93	3,500,000	88,918	20,593	10/29/93	3,566,392	0.16	-185,532
67	FNMA 93-159 B PO	9/30/93	972,000	-	-	9/30/93	984,000	0.00	-14,199
68	FHLMC 1584 SB	9/30/93	905,514	-	-	9/30/93	935,514	0.00	-35,497
69	FNMA 93-221	10/7/93	613,600	-	-	11/8/93	627,500	0.09	-14,265
70	FNMA 93-67 B PO	10/19/93	1,171,632	-	-	4/8/94	903,000	0.47	333,679
71	FNMA 93-205 H	10/29/93	1,185,000	-	-	10/29/93	1,185,000	0.00	0
72	FNMA 93-138 SC IF	11/15/93	1,026,485	48,945	23,257	4/8/94	483,701	0.40	561,831
73	FNR 1650 CL IO	11/24/93	1,094,990	-	-	1/26/94	1,079,288	0.17	25,798
74	FNMA 93-206 SG IF	11/30/93	1,010,000	48,707	12,440	4/8/94	533,283	0.36	496,231
75	FNMA 93-168 SC IF	11/30/93	1,040,889	53,509	24,402	4/8/94	677,362	0.36	345,281
76	FHLMC 1611 PB IF	12/30/93	4,175,000	162,918	255,737	4/8/94	1,613,518	0.27	2,531,163
77	FNMA 93-249 PE PO	12/30/93	862,500	-	53,576	5/6/94	473,212	0.35	399,879
78	FHLMC 1669 MB IF	2/28/94	1,955,000	33,078	2,814	4/8/94	1,038,509	0.11	1,031,737

Total dollar loss as of 9/30/95 on 23 securities with losses: 13,155,657

D Expert's Detailed Portfolio Risk Analysis

In this Exhibit, I describe details of the risk analysis, the findings of which I present in Section 4. The Exhibit contains five parts that contain details on the following topics:

1. The method of calculating the risk-adjusted portfolio holding-period rate of return, beginning on page 50.
2. The specification of historically plausible expectations about interest-rate movements, beginning on page 51.
3. The estimation of the sensitivity of security returns to interest-rate movements, beginning on page 53.
4. The determination of minimally and appropriately prudent degrees of risk aversion, beginning on page 53.
5. The calculation of risk-adjusted rates of return available in the capital markets, beginning on page 58.

Cited references are listed in the bibliographic reference section that begins on page 60.

D.1 Risk-Adjusted Portfolio Rate-of-Return Method

The four-stage method used to estimate the risk-adjusted holding-period rate of return on the Portfolio (see pages 25–26) is the same method used to manage the interest-rate risk of Fannie Mae's mortgage portfolio (Holmer 1994). The procedures used in the first three stages of the method to estimate portfolio holding-period (or horizon) rates of return in each interest-rate scenario were discussed (with examples of how to apply these procedures to pass-through MBS, MBS strips, and CMO tranches) in the finance literature as early as 1989 (Dattatreya and Fabozzi 1989). The procedures used in the fourth stage of the method to calculate the risk-adjusted (or certainty-equivalent) return were discussed in the finance literature as early as 1985 (Cox and Rubinstein 1985, pp. 317–321).

In my 1987–1992 experience at Fannie Mae as vice-president for asset-liability strategy and in my 1992–1993 experience at the Wharton School of the University of Pennsylvania as a lecturer and research associate, this method (in one form or another) was widely used by sophisticated institutional investors in mortgage securities during the early 1990s. These investors viewed the use of any less sophisticated method as being imprudent, in the sense of leaving the investor ignorant of the interest-rate-risk-adjusted rate of return that could be anticipated on a portfolio. These investors thought that such ignorance would expose a mortgage portfolio to a substantial risk of losses.

D.2 Expectations Concerning Interest Rates

The first-stage of the risk-analysis method requires the specification of a number of anticipated interest-rate movements. Generally the historical experience is used to specify these expectations. These expectations can be represented either by a binomial tree or lattice (Holmer 1994) or by a stochastic process (Holmer 1997a). Monte Carlo or stochastic simulation techniques (Hammersley and Handscomb 1964) are used to generate future interest-rate scenarios from either the binomial tree or stochastic process.

The Portfolio risk analysis uses five interest-rate-movement scenarios. The first scenario has interest rates rise and then remain steady so that, at the end of the three-year holding period, rates are two percentage points above where they were at the beginning of the holding period. The second scenario is similar except that rates rise by one percentage point during the holding period. The third scenario calls for stable interest rates throughout the three-year holding period. The fourth and fifth scenarios are mirror images of the second and first scenario, respectively. The fourth involves a one-percentage-point decline in interest rates, while the fifth calls for a decline of two percentage points.

What are the probabilities of these five interest-rate-movement scenarios occurring? To answer this question, I have used the stochastic process for long-term Treasury interest rates in SSASIM, a long-term, stochastic simulation model of social security policy (Holmer 1997b). The parameters of this stochastic process have been estimated using historical data on annual interest-rate movements during the 1926–1994 period. The stochastic process estimation work was undertaken as part of a competitively-awarded Social Security Administration contract and was reviewed by a panel of economists from the Social Security Administration, General Accounting Office, Congressional Budget Office, and TIAA-CREF, among others. Further enhancements to the stochastic process were completed as part of an Employee Benefit Research Institute contract, which also involve an outside review panel (Holmer 1997a).

The SSASIM model was used to generate 1,000 Monte Carlo scenarios and the three-year movement in the Treasury interest rate from a fixed simulation year was calculated for each of the 1,000 scenarios. Table 3 presents the number of the randomly generated scenarios that produced three-year interest-rate movements of different magnitudes.

Table 3: **Number of SSASIM Scenarios Exhibiting Three-Year Interest-Rate Movements of Different Magnitudes**. Results from SSASIM model run 215 that randomly generated 1,000 scenarios.

Magnitude of Three-Year Interest-Rate Movement	Scenarios
less than –1.5 percentage points	102
between –1.5 and –0.5 percentage points	222
between –0.5 and +0.5 percentage points	326
between +0.5 and +1.5 percentage points	248
greater than +1.5 percentage points	102

Based on the results in Table 3, I assigned a probability of 10 percent each to the first and fifth interest-rate-movement scenarios used in the risk analysis, a probability of 25 percent each to the second and fourth scenarios, and a probability of 30 percent to the third scenario that assumes no change in interest rates over the three-year holding period. These interest-rate-movement expectations are, therefore, historically plausible.

This assumed range of interest-rate movements is not as wide as the range the Public Securities Association recommends for CMO tranche analysis. Under the heading "Questions You Should Ask Before Investing in REMICs," PSA suggests that prospective investors ask:

> How will the estimated yield and average life of this REMIC [tranche] change if interest rates move up (or down) by 100, 200, or 300 basis points (100 basis points = 1%)? (PSA 1994, pp. 21–22)

D.3 Security Return Sensitivity to Interest Rates

Two techniques can be used to estimate the sensitivity of a security's holding-period rate of return to movements in interest rates. In the case of securities for which there is no investment experience, an MBS or CMO simulation model must be used (Holmer 1994). For securities on which returns have been experienced in holding periods that exhibited a variety of interest-rate movements, sensitivity estimation can be accomplished using an econometric model. I use this second technique in the risk analysis of the Portfolio because the actual gain and loss data are available for all the securities in the Portfolio.

The Portfolio securities fall into five groups: (1) pass-through MBS, (2) PO strips and super-PO CMO tranches, (3) interest-rate caps, (4) IO strips, and (5) inverse floater CMO tranches. Because each of four groups (the interest-rate cap group has only one security) contain gain/loss data for securities that were held in over periods with differing interest-rate movements, it was possible to estimate an econometric equation for each group that relates the actual holding-period return to a constant term and a measure of interest-rate movement over the actual holding period. The ability of the these four econometric equations to predict the observed returns is quite high. The errors in prediction generally lead to underestimates of the magnitude of negative returns, and in the case of the inverse floaters, which were mostly PAC support or companion tranches subject to substantial call risk, the errors in prediction generally lead to overestimates of high positive returns. The nature of these prediction errors make these four econometric equations conservative predictors of gains and losses, in the sense that they are likely the present a more favorable impression of the return sensitivity of these types of securities than is actually the case.

The parameters of the equation for the one interest-rate cap were calculated from the known option value of the cap at different interest-rate levels and from the known time decay in the value of the cap as it approaches maturity.

D.4 Prudent Degrees of Risk Aversion

The fourth stage of the risk-analysis method involves determining the value of an expected-utility function parameter that represents the degree of risk aversion assumed in calculating the risk-adjusted rate of return from the scenario rates of return. The commonly-used power utility function and the calculation technique that I employ in the analysis are described in many finance textbooks including Cox and Rubinstein (1985, pp. 317–321).

What is explained here is how I determine the minimally prudent and appropriately prudent degrees of risk aversion for pension fund trustees. This determination involves the detailed consideration of a series of four realistic investment portfolios. The methods used in the analysis of these four portfolios are similar to those used to determine the risk attitudes of senior management at Fannie Mae, a study that was undertaken in order to determine the degree of risk aversion that would be used in Fannie Mae's portfolio management decisions (Holmer 1994).

Consider a situation in which pension investments have been made in a portfolio whose average anticipated rate of return is 10%. The uncertain anticipated portfolio return is assumed to have a normal (or bell-shaped) distribution around the average with a standard deviation of 20%. This means that the portfolio rate of return is equally likely to be above or below the 10% average, and that it is anticipated to be between –10% and +30% about two-thirds of the time and between –30% and +50% about ninety-five percent of the time. The uncertain returns on this portfolio are, by construction, similar to the distribution of annual returns over the past seventy years on stocks in the S&P 500 index.

Also assume that the riskless rate of return available on zero-coupon Treasury bonds is 6% in this and all other investment situations considered below. The implied average "equity premium" of four percent reflects the long-run U.S. experience. This riskless return represents an important reference for a pension trustee because it is the guaranteed rate of return that can be obtained for the pension participants. If the trustee invests participants' funds in the risky portfolio, the portfolio's realized return could be above the riskless return, creating a relative gain, or could be below the riskless return, creating a relative loss. The net gain is defined as the difference between the realized portfolio return and the riskless return. For example, if the portfolio's realized rate of return happened to be a below average 2%, then the relative loss is –4% (2% minus 6%) and the net gain is also –4%. If, on the other hand, the realized portfolio return turned out to be a somewhat higher, but still below average, 9%, then the relative loss would be 0% (since the 9% is above the riskless 6%) and the net gain would be +3%.

Table 4 on the following page contains the average relative loss and average net gain for this first portfolio, which is called investment portfolio 1. The estimated average net gain is slightly different from four percent because

Table 4: **Alternative Investment Portfolios and Their Average Relative Loss and Average Net Gain**. Gains and losses are measured relative to a 6% riskless rate of return. The average relative loss and average net gain are tabulated from 100,000 Monte Carlo realizations of the uncertain portfolio return.

Investment Portfolio Number	**Portfolio Return Average**	**Portfolio Return St.Dev.**	**Average Relative Loss**	**Average Net Gain**
1	10.000%	20%	6.124%	4.029%
2	10.000%	22%	6.906%	4.032%
3	10.782%	22%	6.577%	4.814%
4	11.901%	22%	6.124%	5.933%

the 100,000 realized portfolio returns are not perfectly representative of the assumed normal distribution distribution of portfolio returns.

Next consider a second investment portfolio whose uncertain return is the same as that of the first portfolio except that its standard deviation is 22% instead of 20%. This second portfolio's return average is the same 10% as for the first portfolio. This second portfolio is called investment portfolio 2 in Table 4. The average net gain is essentially unchanged at four percent because the average return is unchanged and the higher variance of the uncertain portfolio return means that the likelihoods of higher than average and lower than average returns have increased by equal amounts. This increased likelihood of below average returns causes the average relative loss to increase by 0.782%, from 6.124% for the first portfolio to 6.906% for the second portfolio.

Considering the first and second investment portfolio equally desirable as a pension investment is imprudent because the second portfolio is clearly worse with respect to average relative loss and no better with respect to average net gain. The second portfolio would expose pension participants to unnecessary relative losses. Yet a risk-neutral trustee — one having a 0.0 degree-of-risk-aversion parameter in a power utility function — would find these two portfolio equally desirable. This leads me to conclude that using a zero degree of risk aversion for pension portfolio choice is imprudent.

Putting this another way, a householder would be considered imprudent if s/he were to consider equally desirable the following two options: (1) keeping the family's house for certain and (2) accepting a fifty-fifty chance of either losing the family's house or keeping the house and getting a second house. Yet a householder ranking these two options using expected utility theory and a zero degree of risk aversion would find these two options equally desirable because they both have the same average return of one house and the variability of the return in the second option is of no concern to someone who is risk neutral.

So, a prudent pension trustee who has some positive degree of risk aversion would find the second investment portfolio less desirable than the first. By how much would the distribution of anticipated returns from the second portfolio have to be improved to make them just as desirable as the anticipated returns from the first portfolio? The construction of two additional investment portfolios provides alternative answers to that question, which allow specification of a reasonably prudent range of risk aversion.

Consider a third investment portfolio whose uncertain return is the same as that of the second portfolio except that its return average is somewhat higher. The idea is to increase the return average enough so that the increase in average relative loss caused by the higher return variability in the second over the first portfolio (0.782%) is offset by the same sized increase in average net gain. As shown for investment portfolio 3 in Table 4 on the preceding page, the uncertain return average must be increased from 10% to 10.782% to achieve an increase in average net gain that equals the size of the increased average relative loss caused by the higher return variance. Notice that the average relative loss for this third portfolio is less than that for the second portfolio, but is still higher than the average relative loss on the first portfolio.

To say that a pension trustee considers this third portfolio just as desirable as the first portfolio would be on the border of being imprudent. Any lower return average for the third portfolio would mean that the increase in the average net gain would not fully compensate pension participants for the increase in average relative loss.

A pension trustee having a 1.8 degree of risk aversion would find the risk-adjusted rate of return (or expected utility) of the first and third portfolios exactly equal. Hence the 1.8 value of the power utility function parameter represents for a pension trustee the minimally prudent degree of risk aversion, which is at the border line between imprudence (values below 1.8) and prudence (values above 1.8).

Finally, consider a fourth investment portfolio whose uncertain return is the same as for the second portfolio except that the return average is even higher than that of the third portfolio. The idea is to raise the return average enough so that the increase in average relative loss caused by the higher return variability in the second over the first portfolio (0.782%) is fully offset. As shown for investment portfolio 4 in Table 4 on page 55, the uncertain return average must be increased from 10% to 11.901% to lower the average relative loss back down to its 6.124% value for the first portfolio. Notice that the average net gain for this fourth portfolio is far above the average net gain for the first portfolio.

To say that a pension trustee considers this fourth portfolio just as desirable as the first portfolio would border on excessive prudence. Any higher return average for the fourth portfolio would mean that it had both a lower average relative loss and a higher average net gain than the first portfolio. For a pension trustee to require any better anticipated returns than those of the fourth portfolio would be excessively prudent because the trustee would routinely pass up investment opportunities that would be desirable to pension participants from an average relative loss and average net gain perspective.

A pension trustee having a 3.8 degree of risk aversion would find the risk-adjusted rate of return (or expected utility) of the first and fourth portfolios exactly equal. Hence the 3.8 value of the power utility function parameter represents for a pension trustee the degree of risk aversion that is at the border line between reasonable prudence (values between 1.8 and 3.8) and excessive prudence (values above 3.8).

As described above in the risk-analysis findings section of this report, I designate the midpoint of this reasonably prudent range as the appropriately prudent degree of risk aversion for pension trustees.

This range of reasonably prudent degrees of risk aversion — values between 1.8 and 3.8 — can be defended on both methodological and empirical grounds.

The methodology used in this study of prudent risk aversion is common. This kind of discussion of what increase in the uncertain portfolio return average is required to compensate an investor for being exposed to increased volatility risk is a common way of describing investors' attitudes toward risk (Ingersoll 1987, p. 38). The use of relative gains and losses (the difference between the realization of the uncertain portfolio return and the riskless return) in the discussion is supported by a wide range of studies that show that people consider relative gains and losses (rather than absolute levels) when making decisions under uncertainty (Marquis and Holmer 1996, for example and references). Also, this focus on the average relative loss of an investment portfolio is appropriate for an analysis of prudent risk-taking by pension fund trustees because they have a fiduciary responsibility to the pension plan participants.

From an empirical perspective this range of reasonably prudent degrees of risk aversion for pension trustees represents risk attitudes that are not as risk averse as those found in studies of peoples' personal investment portfolios. There is an empirical literature in economics that attempts to determine people's implied degree of risk aversion based on the average return and return variability of the financial assets actually held in their portfolios. The most recent paper in this literature finds that, in the U.K., people's implied degree of risk aversion is very high, ranging from a value of 7.88 for the most wealthy group to 47.6 for least wealthy group (Blake 1996). These findings are not dissimilar from those of the most recent study of U.S. data by Mankiw and Zeldes, which finds an implied degree of risk aversion of 26.3 according to Blake (1996, p. 1190). So, it is clear that the 1.8-to-3.8 range of reasonably prudent risk aversion is not excessive when viewed in relation to the attitudes toward risk exhibited by pension plan participants in their personal financial decisions.

D.5 Available Risk-Adjusted Rates of Return

After calculating a risk-adjusted Portfolio rate of return using the four-stage method describe above, the final question is how does that risk-adjusted anticipated rate of return compare with the risk-adjusted anticipated rates of return on other investment prospects available in the capital markets. If the Portfolio's risk-adjusted return is substantially below those of other investment prospects available to the Fund's Trustees, then the Portfolio was an imprudent investment.

In this final part of the Exhibit, I explain how the risk-adjusted anticipated rate of return is calculated for a portfolio that consists of equal amounts of long-term U.S. Treasury bonds and stocks represented by the S&P 500 index. This bond-and-stock portfolio represents a plausible alternative for the Trustees because its is similar to the holding of the Fund's two bond-and-stock investment managers during the 1988–1994 period.

In order to calculate the risk-adjusted anticipated rate of return on this bond-and-stock portfolio, a distribution of return magnitudes and probabilities is required for the expected-utility computations. This return distribution was generated using the SSASIM model, a stochastic simulation model that was originally developed to analyze different bond/stock mixes as investment options for the Social Security trust funds (Holmer 1997b, Holmer 1997a, Holmer and Bender 1996). SSASIM run 215 assumes a long-run average Treasury interest rate of 6.3 percent, which is the standard assumption of the Social Security trustees, and a long-run average stock rate of return of 10.3 percent, which is the U.S. average over the 1926–1994 period. This simulation run produces 1,000 Monte Carlo scenarios, the results of which are a mean (standard deviation) of 5.88 (4.88) percent for the three-year annualized bond rate of return and of 8.61 (12.21) for the three-year annualized stock rate of return. Averaging each scenario's bond and stock returns produced a scenario bond-and-stock portfolio rate of return for each scenario. The mean (standard deviation) of that portfolio return distribution is 7.25 (6.63) percent.

Using this portfolio return distribution, a power utility function, and a 1.8 degree of risk aversion, the certainty-equivalent (or risk-adjusted) bond-and-stock portfolio rate of return is 6.88 percent. This value is shown by the horizontal dotted line in the minimally prudent Figure 7 on page 31.

Using this same portfolio return distribution, a power utility function, and a 2.8 degree of risk aversion, the certainty-equivalent (or risk-adjusted) bond-and-stock portfolio rate of return is 6.68 percent. This value is shown by the horizontal dotted line in the appropriately prudent Figure 8 on page 32.

References

Blake, David. "Efficiency, Risk Aversion and Portfolio Insurance: An Analysis of Financial Asset Portfolios Held by Investors in the United Kingdom." *Economic Journal*, September 1996, *106*(438), pp. 1175–1192.

Cox, John C. and Rubinstein, Mark. *Options Markets.* Englewood Cliffs, NJ: Prentice-Hall, 1985.

Dattatreya, Ravi E. and Fabozzi, Frank J. *Active Total Return Management of Fixed Income Portfolios.* Chicago: Probus Publishing, 1989.

Department of Labor. "Connecticut Plumbers and Pipefitters: Analysis of CMO Investments." U.S. Department of Labor Memorandum (with attached three-page data table) from Michael Schloss to J.C. Nickens, Paul Ondrasik, and Edward A. Scallet, July 18, 1996.

Golub, Ben; Holmer, Martin; McKendall, Raymond; Pohlman, Larry; and Zenios, Stavros. "A Stochastic Programming Model for Money Management." *European Journal of Operational Research*, September 1995, *85*(2), pp. 282–296.

Hammersley, J.M. and Handscomb, D.C. *Monte Carlo Methods.* London: Chapman and Hall, 1964.

Hassenmiller, Steven G. "Deposition of Steven G. Hassenmiller: Volume I and Volume II." Deposition taken in *Herman v. Hassenmiller, et al.* on June 4–5, 1997.

Holmer, Martin R. "The Asset/Liability Management Strategy System at Fannie Mae." *Interfaces*, May-June 1994, *24*(3), pp. 3–21.

Holmer, Martin R. "Stochastic Simulation of Social Security Reform Growth and Risk Effects." Policy Simulation Group working paper, June 30, 1997a. (`r970630.pdf` at `<http://www.access.digex.net/~holmer>`)

Holmer, Martin R. "Guide to EBRI-SSASIM2, A Social Security Policy Simulation Model." Policy Simulation Group working paper, June 30, 1997b. (`guide.pdf` at `<http://www.access.digex.net/~holmer>`)

Holmer, Martin R. "Integrated Asset-Liability Management: An Implementation Case Study," in William T. Ziemba and John M. Mulvey, eds., *World Wide Asset and Liability Modeling*, Cambridge, UK: Cambridge University Press, forthcoming.

Holmer, Martin R. and Bender, Christopher S. "Stochastic Simulation of Trust Fund Asset Allocation," in *Report of the 1994-1995 Advisory Council on Social Security, Volume II*, Washington, DC: U.S. Government Printing Office, 1996, pp. 431–450.

Holmer, Martin R. and Zenios, Stavros A. "The Productivity of Financial Intermediation and the Technology of Financial Product Management." *Operations Research*, November-December 1995, *43*(6), pp. 970–982.

Ingersoll, Johathan E., Jr. *Theory of Financial Decision Making.* Savage, MD: Rowman & Littlefield, 1987.

Krzywicki, Frank R. "Deposition of Frank R. Krzywicki: Volume I and Volume II." Deposition taken in *Herman v. Hassenmiller, et al.* on July 16–17, 1997.

Marquis, M. Susan and Holmer, Martin R. "Alternative Models of Choice Under Uncertainty and Demand for Health Insurance." *Review of Economics and Statistics*, August 1996, *78*(3), pp. 421–427.

McKendall, Raymond; Zenios, Stavros; and Holmer, Martin. "Stochastic-Programming Models for Portfolio Optimization of Mortgage-Backed Securities: A Comprehensive Research Guide," in R.L. D'Ecclesia and S.A. Zenios, eds., *Operations Research Models in Quantitative Finance*, Berlin: Springer-Verlag, 1994.

Office of Federal Housing Enterprise Oversight (OFHEO). *1997 Annual Report to Congress.* Washington, DC: U.S. Government Printing Office, June 15, 1997.

Public Securities Association (PSA). *An Investor's Guide to Pass-Through and Collateralized Mortgage Securities.* New York: Public Securities Association, 1993.

Public Securities Association (PSA). *An Investor's Guide to Real Estate Mortgage Investment Conduits (REMICs)*. New York: Public Securities Association, 1994.

Schloss, Michael. "Fax of Table 6: Total Fund rates of return [marked SA0270]; Table 5: Balanced Portfolio Performance [marked SA0095]; and Table 9: Special Study, Total fund rates of return, Comparison with yardsticks annually [marked CPP003532]." U.S. Department of Labor Fax to Martin Holmer, July 1, 1997.