

# The Quarterly Review Of Interest Rate Risk

Office of Supervision,  
Economic Analysis Division



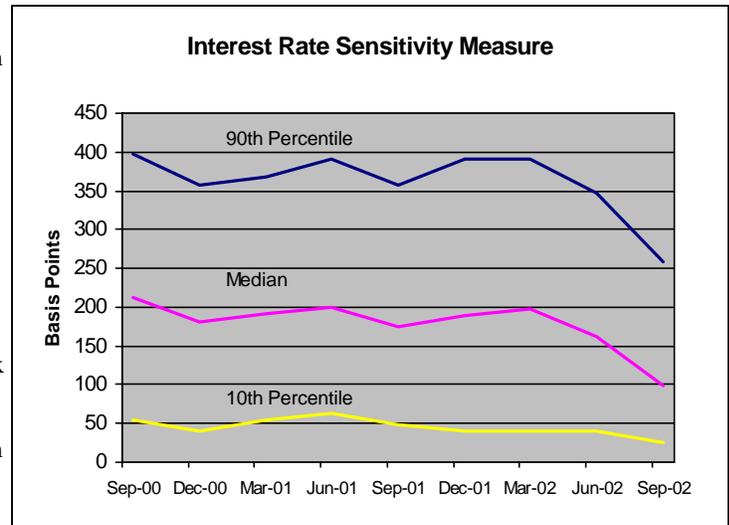
### Special points of interest:

- 30-yr mortgage rate falls
- Yield curve falls in third quarter
- Third quarter sees median interest rate sensitivity fall sharply
- Asset duration falls due to rise in the rate of mortgage prepayments
- Feature Article on Falling Interest Rates and Negative Duration Gaps

## Median Sensitivity Drops Sharply in the Third Quarter

Median thrift sensitivity fell to 98 basis points in the third quarter, down from 161 basis points in June. This sharp decrease reflects the fall in interest rates between the second and third quarters.

The median pre-shock Net Portfolio Value (NPV) ratio fell between the second and third quarters, and the median post-shock NPV ratio also declined. The third quarter saw the number of thrifts with high interest rate risk fall to one, down from eight thrifts in the previous quarter.



See details inside, starting on page 4.

## Falling Interest Rates and Negative Duration Gaps

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Much has been written recently about the development of a negative duration gap at Fannie Mae. This naturally raises questions such as: What exactly does a negative duration gap mean? What portfolio characteristics and market forces bring it about? And, are these same forces also having an effect on the thrift industry?

### Negative Duration Gap

A negative duration gap refers to the situation where the duration of assets is less than that of liabilities. This means that the weighted average duration of the assets a financial in-

stitution holds in its portfolio is less than the weighted average duration of the liabilities it holds in its portfolio. A closely related measure is the leverage-adjusted duration gap, which accounts for the difference between the durations of assets and liabilities by multiplying the duration of liabilities by the liabilities-to-assets ratio.

Before one can fully appreciate duration gap, one must first be familiar with the concept of duration. What is duration? In the most basic sense, it measures the sensitivity of an asset or liability's market value to changes in interest rates. Thus, it is very similar to a concept in eco-

nomics known as elasticity.

Everyone who has taken a course in microeconomics has been exposed to the price elasticity of demand. This measures the percentage change in the quantity demanded of a commodity brought about by a given percentage change in the price of the commodity, holding everything else constant. Duration then can be seen as an appropriate measure of the elasticity, or sensitivity, of the market value of an asset or liability to small changes in interest rates.

Duration gap is a measure of the sensitivity of an entire portfolio's market value net worth to changes

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## Falling Interest Rates and Negative Duration Gaps (continued)

(Continued from page 1)

in interest rates, and is computed as the difference between the duration of assets and the duration of liabilities.

Why is it called duration in the first place, since this would seem to connote time, instead of price sensitivity? In its original form, Frederick Macaulay developed duration back in the 1930s as a measure of the average maturity of a bond's promised cash flows.

"Macaulay duration" is the weighted average time to arrival of cash flows on a bond and is measured in years. Such a measure is an improvement over simple maturity because it provides a more precise linkage between changes in interest rates and changes in the market value of a bond. Macaulay duration can also be seen as the elasticity of the market value of a simple bond with respect to a given small change in its discount factor. However, while Macaulay duration may be an appropriate measure of the elasticity of the market value of a simple bond, it has serious shortcomings when applied to instruments with embedded options.

Yet another measure of duration is "effective duration." Effective duration is a measure of the average price change between two points along the price/yield curve. It is customary to measure effective duration between up and down 100 basis points from the current required yield. However, there is no reason it could not be measured between

+/- one basis point.

In addition, unlike Macaulay duration, effective duration accounts for embedded options by quantifying the effect of interest rate changes on expected cash flows.

### **Portfolio Characteristics and Market Forces Producing Negative Duration Gaps**

When rates fall, as they have been doing for the past several quarters, the market value of equity falls - as does net interest margin - for financial institutions having negative duration gaps. The market value of equity falls because the market value of assets increases less than the market value of liabilities. (Net interest margin also declines because, when rates fall, the interest earned on re-priced assets falls, while there is a greater lag in the downward adjustment of interest paid on liabilities.) Just the opposite occurs for institutions having positive duration gaps when rates fall.

It is not quite as simple as that, however, because durations themselves are functions of the level of interest rates. So, if rates change, the durations of assets and liabilities (as well as off-balance-sheet positions) will also change. As rates change, durations change due to the changing degree of curvature, or convexity, along the price/yield curve.

Thus, if we experience a period of significant and protracted interest rate declines, as we have over

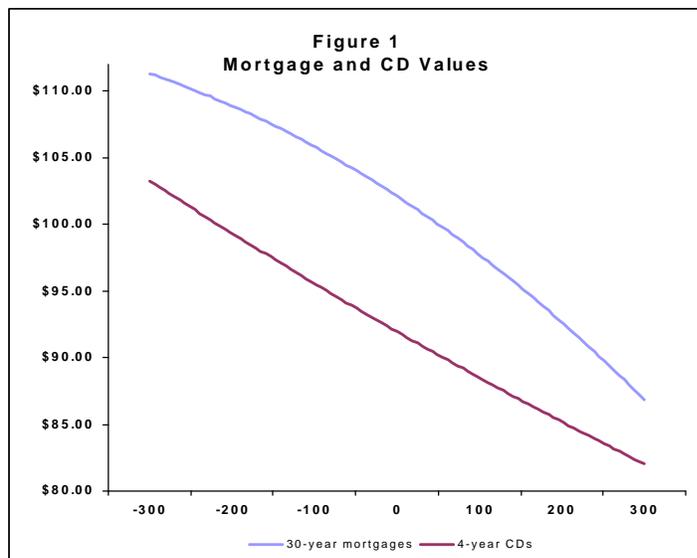
the past two years, the question is whether the duration of assets will change more than the duration of liabilities, and in which direction they will each move.

For a stylized thrift holding 30-year fixed-rate mortgages, funded with four-year CDs, what will likely happen is that the duration of assets will decline, while the duration of liabilities will increase. Figure 1 illustrates this point using the price/yield curves of these two types of instruments. What will actually happen

falling interest rates, while that for CDs becomes steeper is that the borrower has an option to prepay a mortgage, which does not apply to CDs.

When the slope of the price/yield curve increases at an increasing rate as rates fall—as in the case of the CDs depicted in Figure 1—the instrument is said to have positive convexity. Just the opposite situation holds for mortgages in Figure 1, and these instruments are said to have negative convexity.

Figure 2 plots the *dif-*



in any particular case is also a function of the mortgage coupon rate and the yield on the CDs, and where these are in relation to the market.

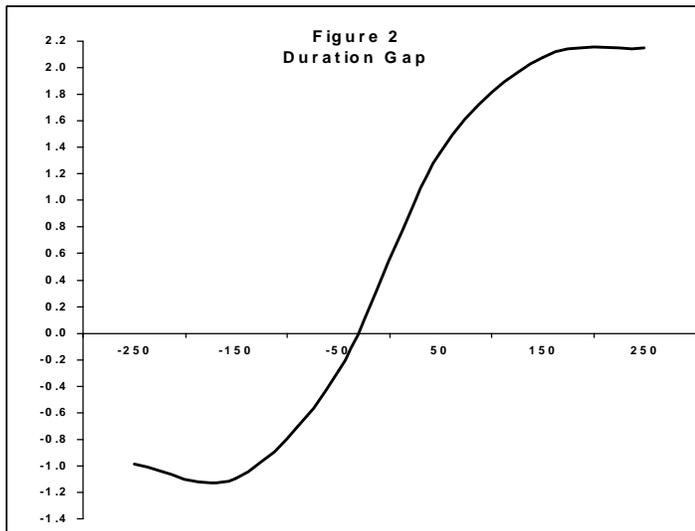
The curves depicted in Figure 1 are based on data from the OTS *Price Tables* for September 2000 for 30-year fixed-rate mortgages with a 9.5 percent coupon and four-year CDs with a 4.5 percent yield. The reason the price/yield curve for mortgages flattens with

reference between the effective duration of the 30-year fixed-rate mortgages and the effective duration of the four-year CDs depicted in Figure 1 for the different interest rate scenarios used in the NPV Model. (The durations are given by the slope of the price-yield curves for a given interest rate level).

As the market's required yield falls, the duration gap between assets and liabilities gets

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Falling Interest Rates and Negative Duration Gaps (continued)



(Continued from page 2)

smaller, and then becomes negative with additional decreases in yield.

A complicating factor is that interest rate declines bring about changes in the weighted average coupon of mortgages held in a financial institution's portfolio. During the past year, mortgage refinancings have been at all-time highs with the successive decreases in rates made by the Federal Reserve. As a result, lower-coupon mortgages have been replacing higher-coupon mortgages.

Fannie Mae, which issues mortgage-backed securities against the mortgages it purchases from financial institutions, has been significantly affected by the recent surge in mortgage prepayments, as have other financial institutions having large portfolio holdings of mortgages and mortgage-backed securities.

Thus, not only do changes in the market's required yield elicit

changes in the estimated portfolio net worth of a static portfolio, they also bring about changes in portfolio composition as lenders and borrowers respond to the changing market conditions. These changes in portfolio composition, in turn, will produce changes in interest rate sensitivity.

Consider, for example, an institution holding 7.5 percent 30-year fixed rate mortgages, when the market's required yield on newly issued loans of this type is 6.0 percent. The duration of the 7.5 percent mortgage portfolio will be relatively small, due to the high likelihood of prepayment. If we assume that all these mortgages suddenly prepay and are replaced by new 6.0 percent loans, the result will be little or no change in the market value of mortgages held, but a significant increase in their duration, and therefore in their interest rate sensitivity.

The duration of the new mortgages will be much larger than that of the old mortgages be-

cause the prepayment risk of the new mortgages is minimal.

**Negative Duration Gaps and Recent Experience of the Thrift Industry**

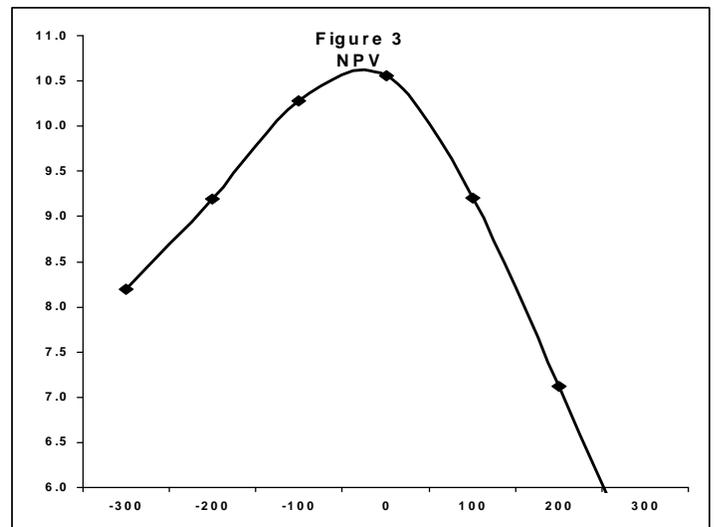
The same factors that led to the increasingly negative duration gap at Fannie Mae have also had significant effects on the thrift industry over the same period. For example, the percentage of thrifts having a positive effective duration gap fell from 86 percent in March of this year to 79 percent in June, and to 65 percent in September. These changes reflect a fall in the yield curve during the second and third quarters.

Even more striking is the fact that 53 percent of thrifts reporting would suffer a loss of value if rates fell an additional 100 basis points from

end of June.

For the typical traditional thrift that has a substantial portion of its portfolio in mortgages and mortgage-backed securities, which are funded by shorter-term liabilities, a tendency toward a declining, or even a negative, duration gap is to be expected while going through a protracted period of declining rates. This situation raises regulatory concerns that are in sharp contrast to the traditional concerns about the interest rate risk of thrifts - namely, that they fund long-term assets with short-term borrowings.

The funding of long-term assets with short-term borrowings is a big concern in a rising rate environment, and is what resulted in the industry having a negative market value net worth in 1980 and 1981. However, in a falling rate environment,



where they were at the end of September 2002. This is a large increase over the 32 percent that were so affected at the

the ostensibly long-term assets (mortgages) turn out not to be very long-term at all, as a result of

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## Falling Interest Rates and Negative Duration Gaps (continued)

*(Continued from page 3)*

accelerated prepayments.

Thus, thrifts can suffer decreases in their market value of equity in either a protracted falling rate environment or a protracted rising rate environment. This situation is illustrated in Figure 3, which shows what happens to the estimated market value of portfolio net worth of a stylized thrift holding the instruments depicted in Figure 1 for various interest rate scenarios.

The loss of value due to falling rates is lessened by the point and fee income generated by mortgage refinancings. It could also be lessened through the greater use of callable (i.e., where the thrift holds the prepayment option) FHLB advances.

But thrifts tend not to use these instruments, opting instead for puttable FHLB advances, which

worsen their exposure to rising rates and do nothing for them in a period of falling rates. (See the June 2001 and September 2001 issues of this publication for more on this subject.)

Financial institutions can use a variety of alternative approaches to control the size of their duration gaps in the management of interest rate risk. These approaches include holding more adjustable-rate mortgages, the use of hedging strategies based on financial derivative instruments, continual portfolio rebalancing, or the aforementioned use of FHLB callable advances.

As time passes, the time remaining to maturity of existing assets and liabilities held in a financial institution's portfolio will fall, market interest rates will change, and portfolio composition will change due to turnover.

All these changes mean that the durations of assets and liabilities are continually changing. If an institution plans to maintain a particular duration gap, it will find that the duration gap has to be managed dynamically.

An institution can use an asset/liability management model to measure the loss of value associated with a given rate change with greater precision. In this case, it is not necessary to know the durations of assets and liabilities *per se*; nevertheless, duration values are implied in such model results.

The OTS Net Portfolio Model produces, as a by-product of generating its sensitivity measures, the effective durations of assets, liabilities, and equity. Such measures provide an easy-to-use reference as to how much sensitivity a portfolio has and

in which key portfolio components it is concentrated.

Those institutions paying less careful attention to duration gaps and interest rate sensitivity will probably want to hold more capital as a cushion against interest rate shocks.

## Median Sensitivity Drops Sharply in the Third Quarter (continued)

*(Continued from page 1)*

Treasury rates fell at all maturities between the second and third quarters. However, short-term rates fell less than medium- and long-term rates. The 30-year mortgage rate declined to 5.98 percent at the end of the third quarter from 6.55 percent at the end of the second quarter.

The fall in the yield curve allowed the already favorable lending environment to persist for the thrift industry for yet another quarter. Thus, profitability remained healthy with the movements in the yield curve producing

somewhat offsetting, and therefore mixed, net results.

The decline in the yield curve, to the extent that fixed-rate mortgages prepay and ARMs reprice, means that institutions will have lower yielding assets on their books. This same decline in the yield curve means that institutions should have lower costs of funding (to the extent that liabilities reprice).

Net interest margin rose from 318 basis points in June to 320 basis points in September for the median thrift. While the median net in-

terest margin rose by two basis points during the third quarter, the average net interest margin fell by ten basis points. These changes are consistent with the fact that net interest margin rose for thrifts under \$1 billion and fell for those thrifts over \$1 billion.

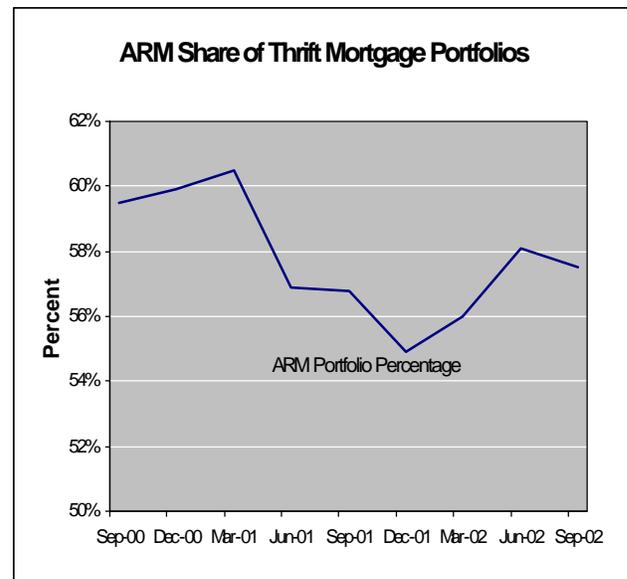
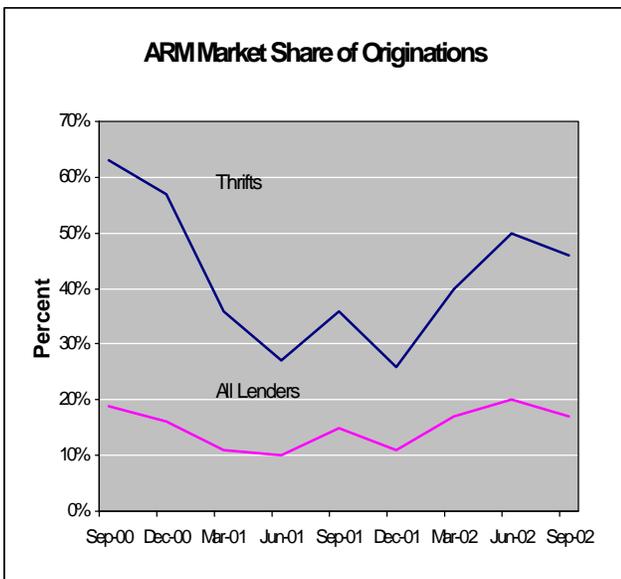
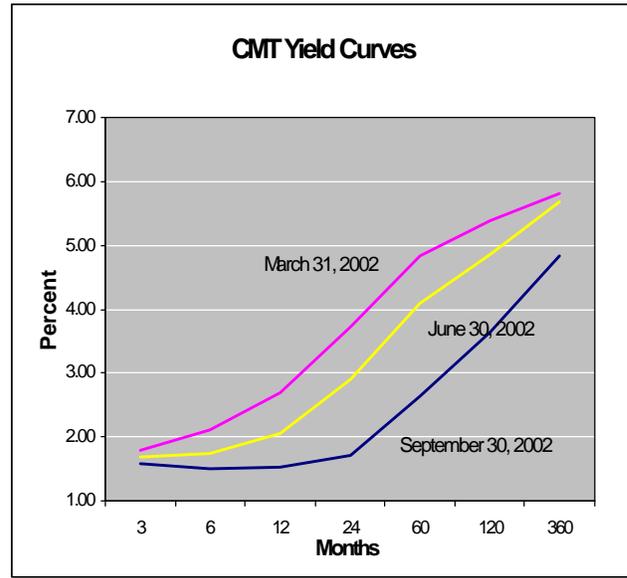
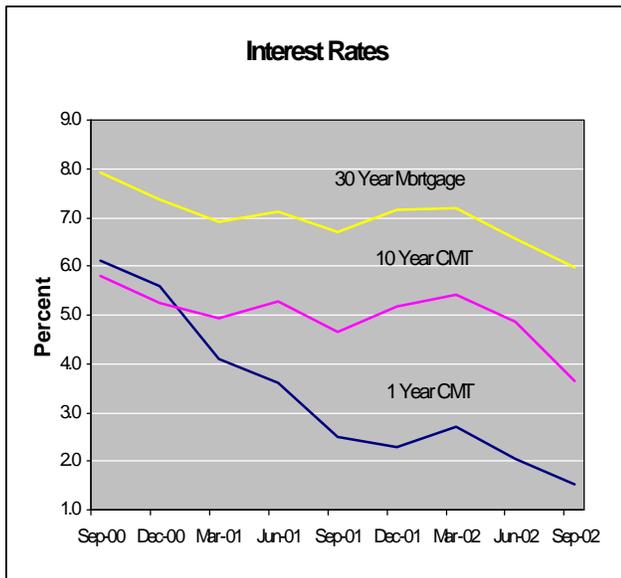
Aggregate thrift industry earnings rose in the third quarter to \$2.97 billion, up from the \$2.84 billion in the second quarter. The decline in net interest margin was more than offset by third-quarter increases in income from sources unrelated to interest rates,

such as retail banking fees, mutual fund and annuity sales commissions, and loan servicing income from nonmortgage loans.

The ARM share of total thrift mortgage originations fell to 46 percent, down from 50 percent in the prior quarter. Along with the relative fall in ARM originations, the ARM share of total 1-4 family mortgages held in portfolio fell to 57.5 percent from 58.1 percent in the second quarter.

The third quarter saw a jump in mortgage originations due to a higher rate of refinancings. Third-quarter 1-4 family

## Interest Rates and ARM Market Share



### Median Sensitivity Drops Sharply in the Third Quarter (continued)

mortgage originations by thrifts stood at \$122.0 billion, up sharply from \$92.8 billion in the second quarter. Total mortgage originations in the third quarter were \$138.0 billion, up from \$109.2 billion in the second quarter.

Thrifts' share of all 1-4 family originations was 17.6 percent in the third quarter, down from 20.0

percent in the second quarter. The third quarter witnessed a slight increase in the rate of U.S. home ownership, rising to 68.0 percent from 67.6 percent.

Refinancing accounted for 39.7 percent of thrift originations of single-family mortgages in the third quarter, up from 30.3 percent in the second quarter. This jump is con-

sistent with the refinancing activity of all lenders, where the rate rose to 60 percent in the third quarter, up from 43 percent in the prior quarter.

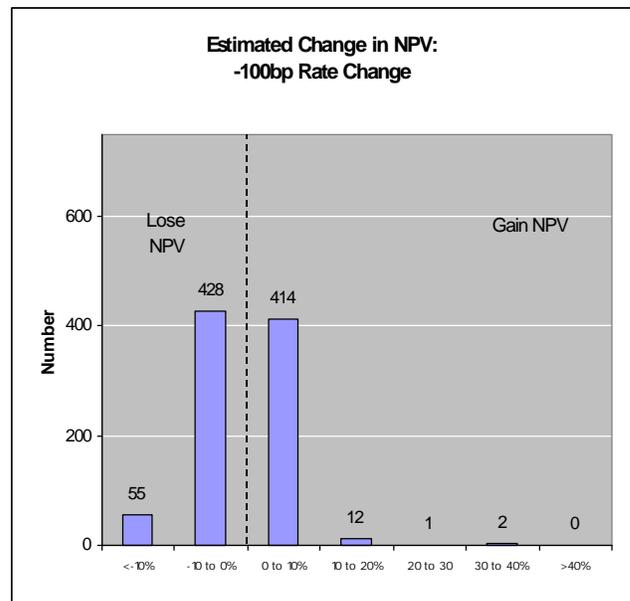
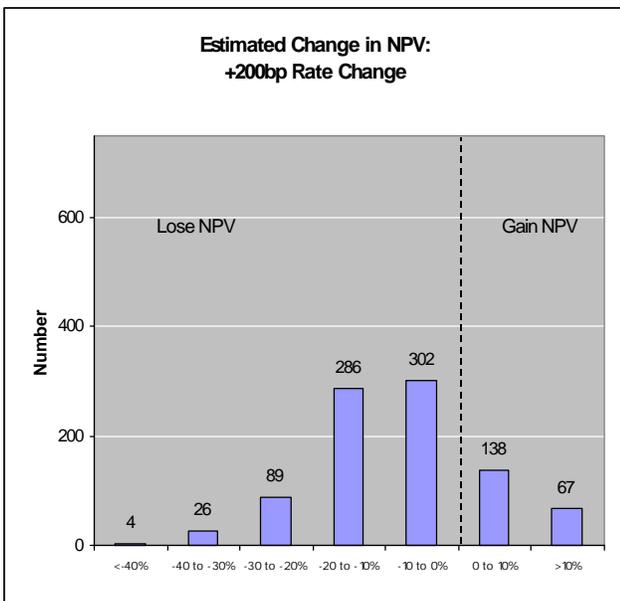
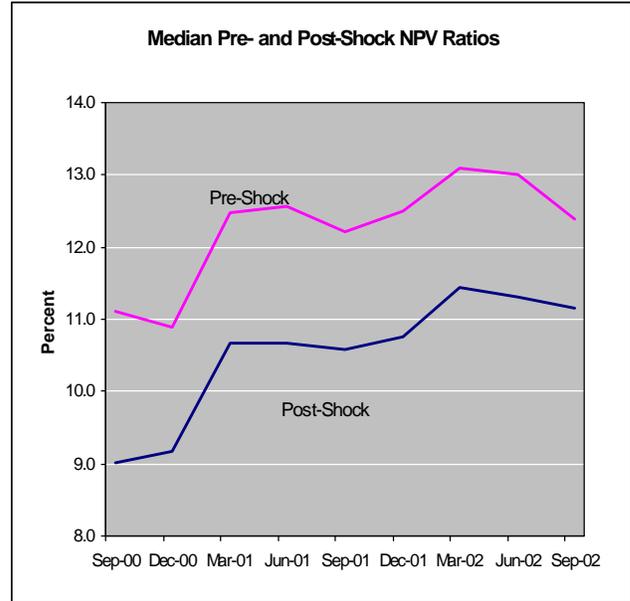
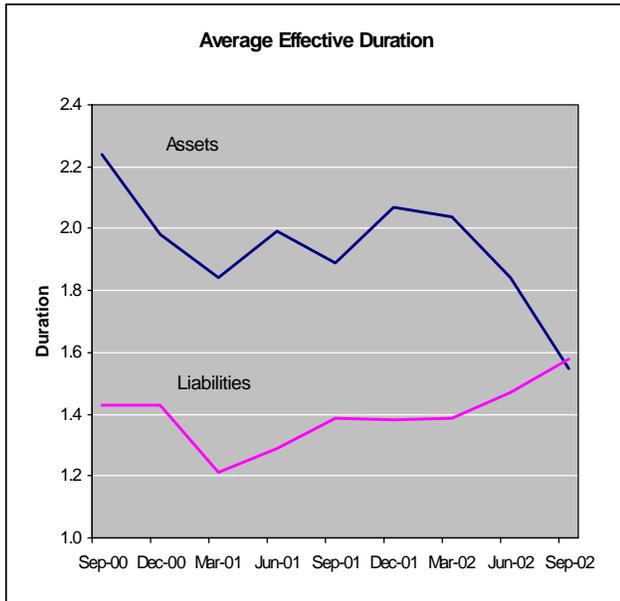
Other effects of the fall in the yield curve in the third quarter are to shorten the duration of assets and increase the duration of liabilities. Consistent with this, the percent-

age of thrifts having a negative effective duration gap increased substantially from 21 percent to 35.4 percent.

Thus, the same factors that produced a negative duration gap at Fannie Mae, as discussed in the feature article on p. 1 of this publication, have had similar effects on the thrift

*(Continued on page 6)*

## Duration and NPV Sensitivity Measures



### Median Sensitivity Drops Sharply in the Third Quarter (continued)

(Continued from page 5) industry. Thrifts with negative duration gaps are affected adversely when rates fall, and vice versa. Just the opposite situation occurs for thrifts having positive duration gaps.

The industry's average effective duration of assets fell from 1.84 to 1.55 between the second and third quarters. With a fall

in rates, the NPV Model predicts an increase in mortgage prepayments, which lowers mortgage duration, and, therefore, assets duration. The industry's average effective duration of liabilities rose from 1.55 to 1.58 in the third quarter.

The median pre-shock NPV ratio for the industry fell between the second

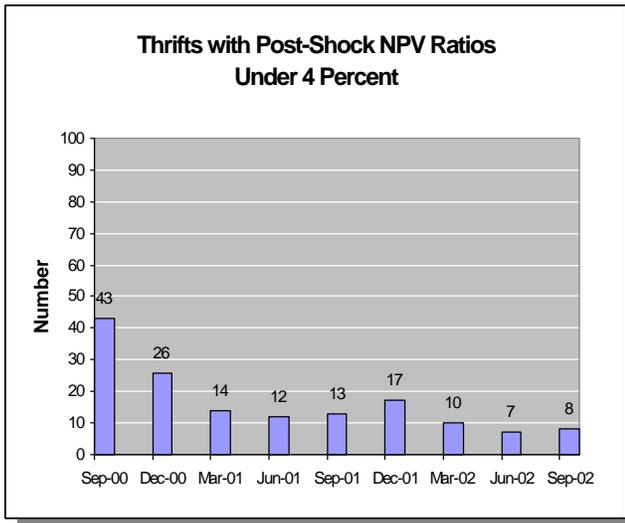
and third quarters from 13 percent to 12.4 percent due to the fall in rates combined with the shortening of assets duration and lengthening of liabilities duration. Despite this fall in the median pre-shock NPV ratio, the median post-shock NPV ratio fell only slightly to 11.2 percent in the third quarter, down from 11.3 per-

cent in the prior quarter. This was due to the dramatic drop in median sensitivity.

At the end of the third quarter, a 200 basis point increase in rates would produce a net portfolio value loss for 707 thrifts, while 205 thrifts would see their net portfolio values rise. If rates fell by 100 ba-

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## Interest Rate Risk Measures



	NPV as % of PV of Assets		% Change in NPV	
	Jun-02	Sep-02	Jun-02	Sep-02
<b>+300</b>	9.70%	9.91%	-19%	-9%
<b>+200</b>	10.60%	10.49%	-10%	-3%
<b>+100</b>	11.20%	10.72%	-3%	1%
<b>Base</b>	11.50%	10.58%	0%	0%
<b>-100</b>	11.30%	10.39%	0%	-1%
<b>-200</b>	N/A	N/A	N/A	N/A
<b>-300</b>	N/A	N/A	N/A	N/A

	Under 100bp	101-200bp	201-400bp	Over 400bp	Total
<b>Over 10%</b>	227	147	204	27	605
<b>6% to 10%</b>	87	77	108	14	286
<b>4% to 6%</b>	2	6	8	3	19
<b>Below 4%</b>	1	1	3	2	7
<b>Total</b>	317	231	323	46	917

Minimal
Moderate
Significant
High

	Under 100bp	101-200bp	201-400bp	Over 400bp	Total
<b>Over 10%</b>	299	154	118	8	579
<b>6% to 10%</b>	155	95	43	5	298
<b>4% to 6%</b>	13	6	8	0	27
<b>Below 4%</b>	2	5	0	1	8
<b>Total</b>	469	260	169	14	912

Minimal
Moderate
Significant
High

### Median Sensitivity Drops Sharply in the Third Quarter (continued)

(Continued from page 6)  
 sis points, 483 thrifts would see their net portfolio values decrease, while 429 thrifts would see an increase in their net portfolio values.

The number of thrifts with a post-shock NPV ratio below 4 percent rose to eight from seven in the previous quarter. This represents the first quar-

terly increase since December 2001.

With a 200 basis point increase in interest rates, the thrift industry would lose 3 percent of its net portfolio value. This is down sharply from 10 percent in the previous quarter, and is consistent with the dramatic fall in median sensitivity.

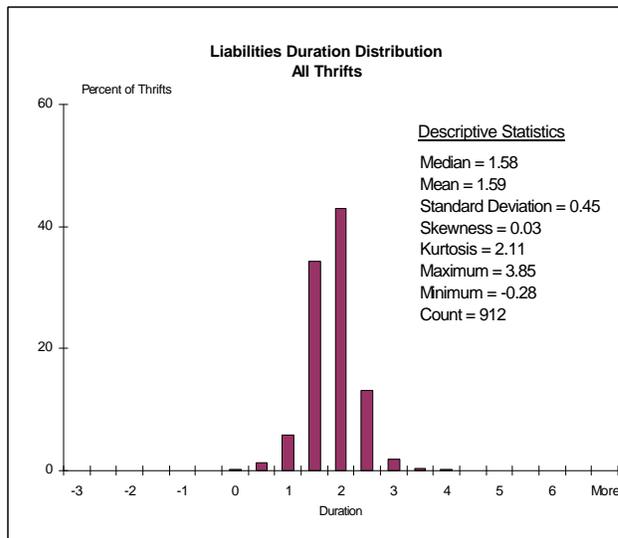
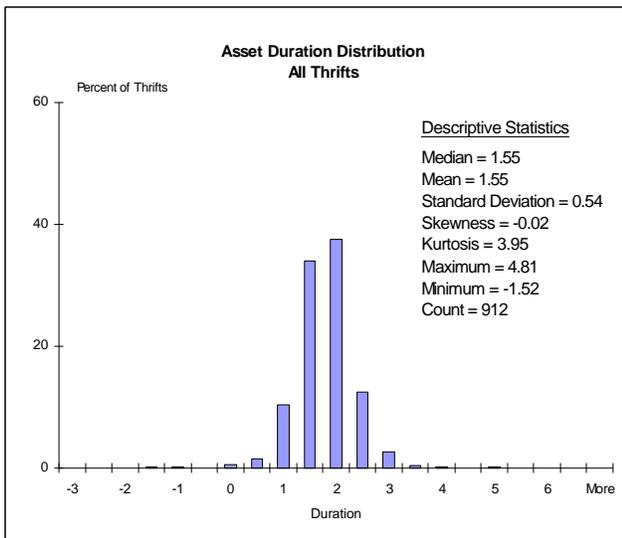
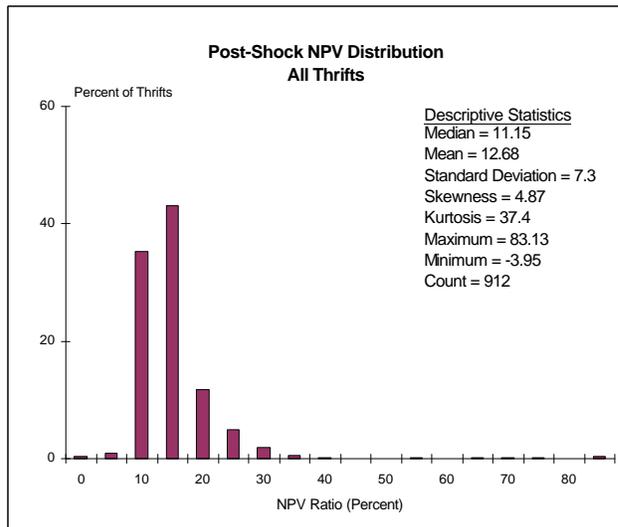
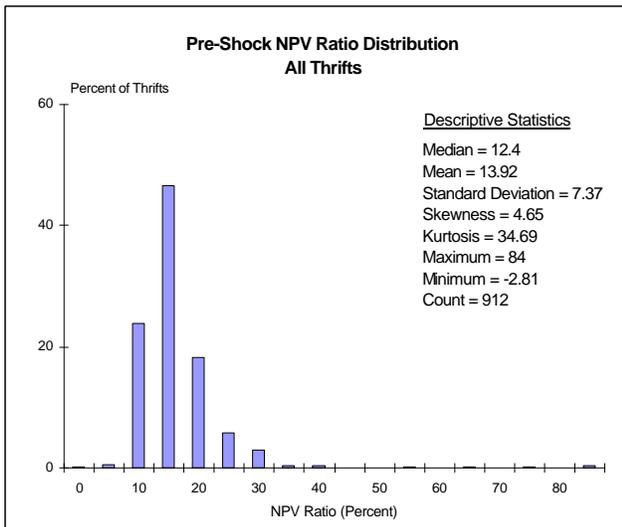
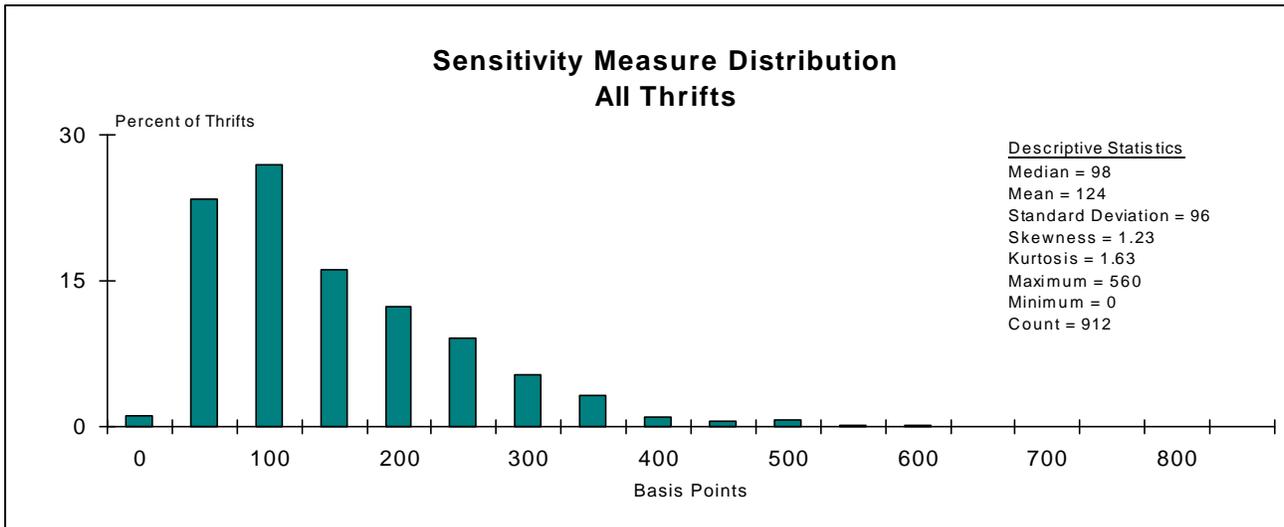
The percentage of

thrifts with a post-shock NPV ratio over 6 percent decreased slightly between the second and third quarters. In the third quarter, such thrifts comprised 96.1 percent of the industry compared to 97.2 percent in the prior quarter.

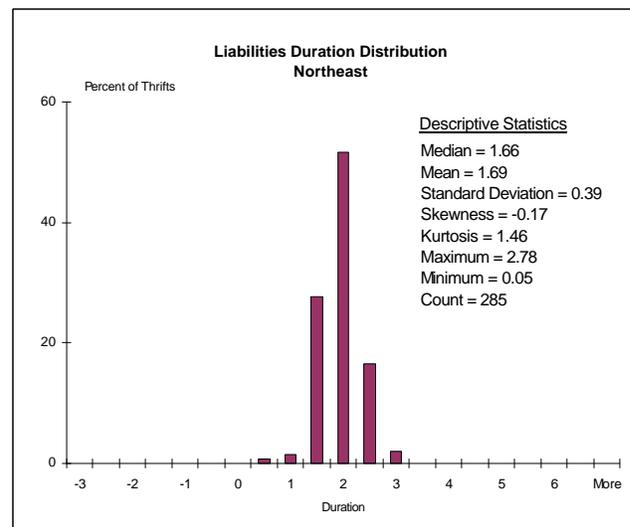
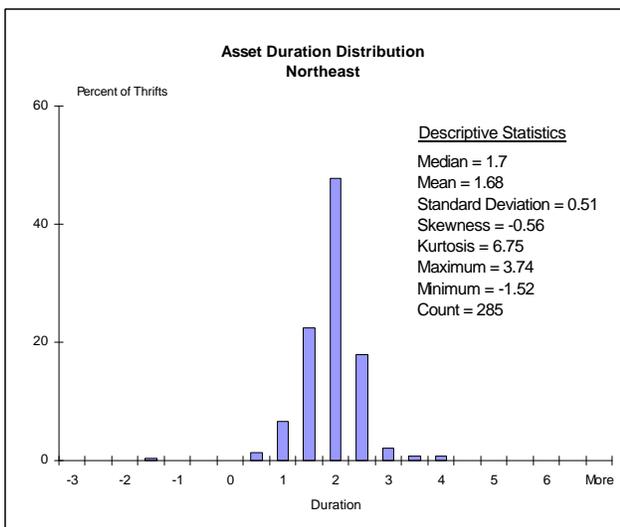
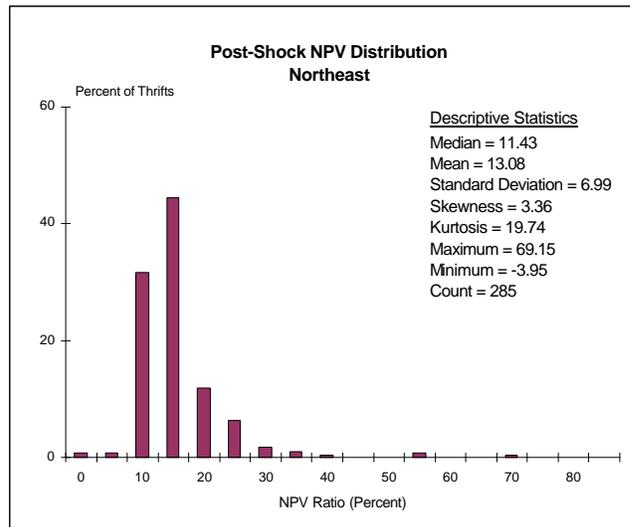
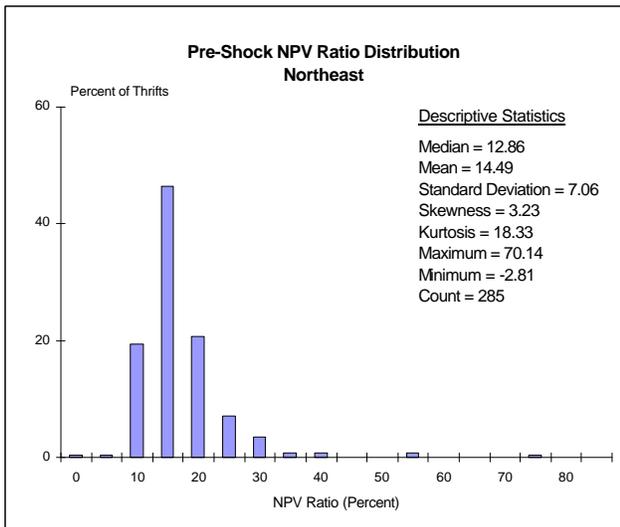
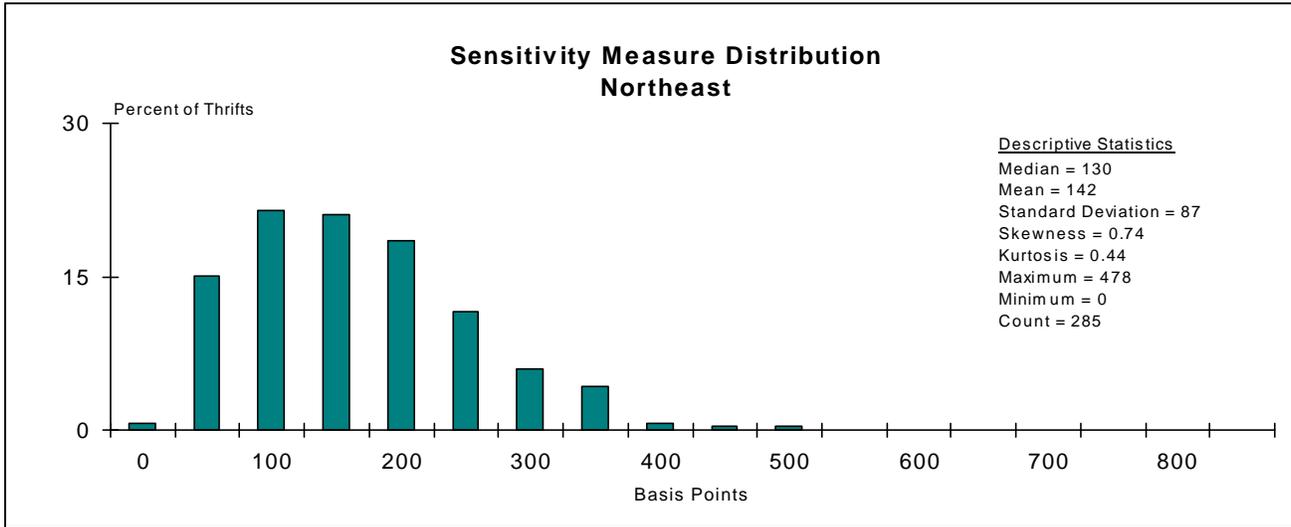
The number of thrifts with a post-shock NPV ratio below 6 percent rose slightly to 35 in the third

quarter, up from 26 in the second quarter. The number of thrifts with a sensitivity of 200 basis points or less increased to 729 in the third quarter, from 548 in the second quarter. The number of thrifts with over 400 basis points in sensitivity fell to 14, down from 46 in the prior quarter.

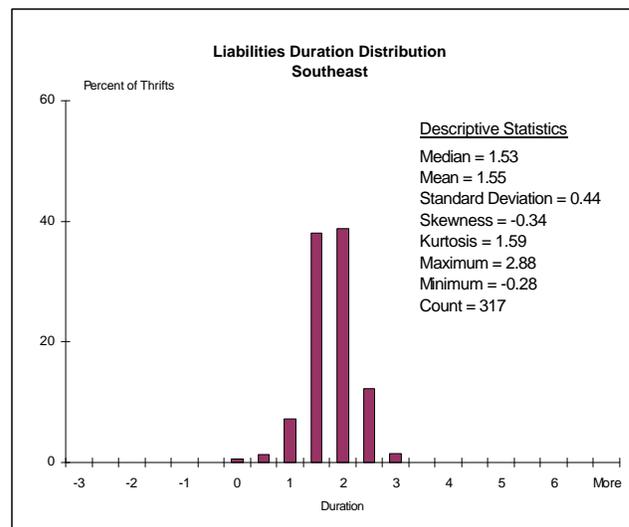
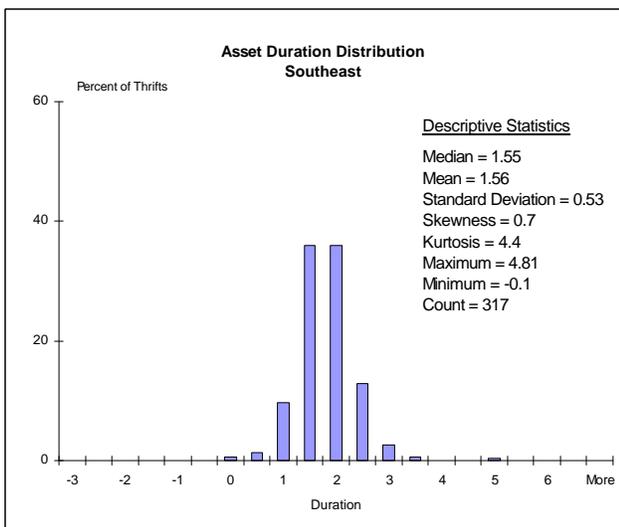
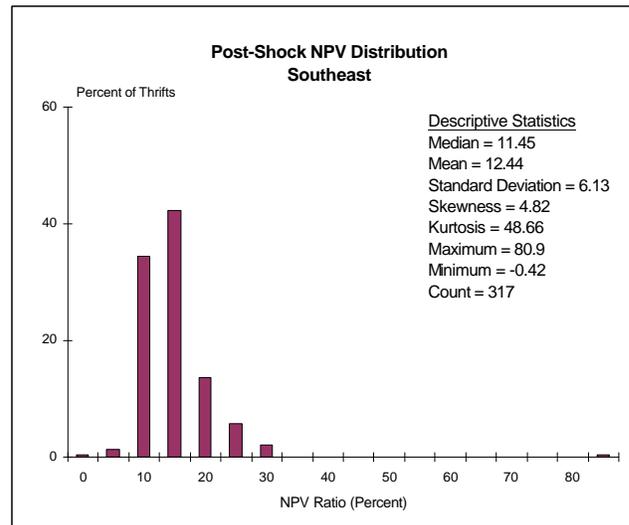
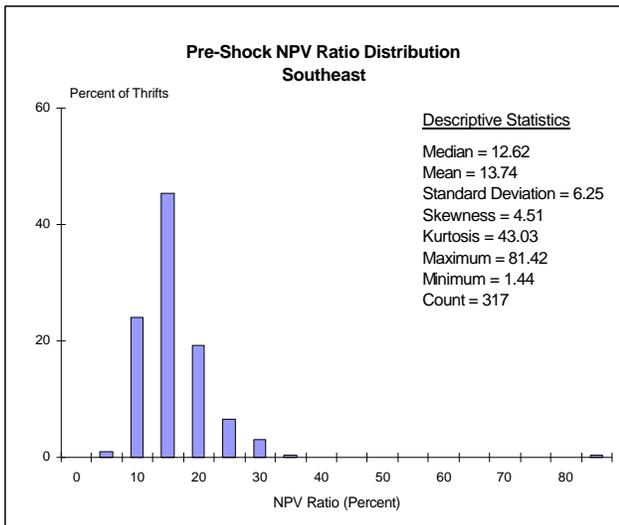
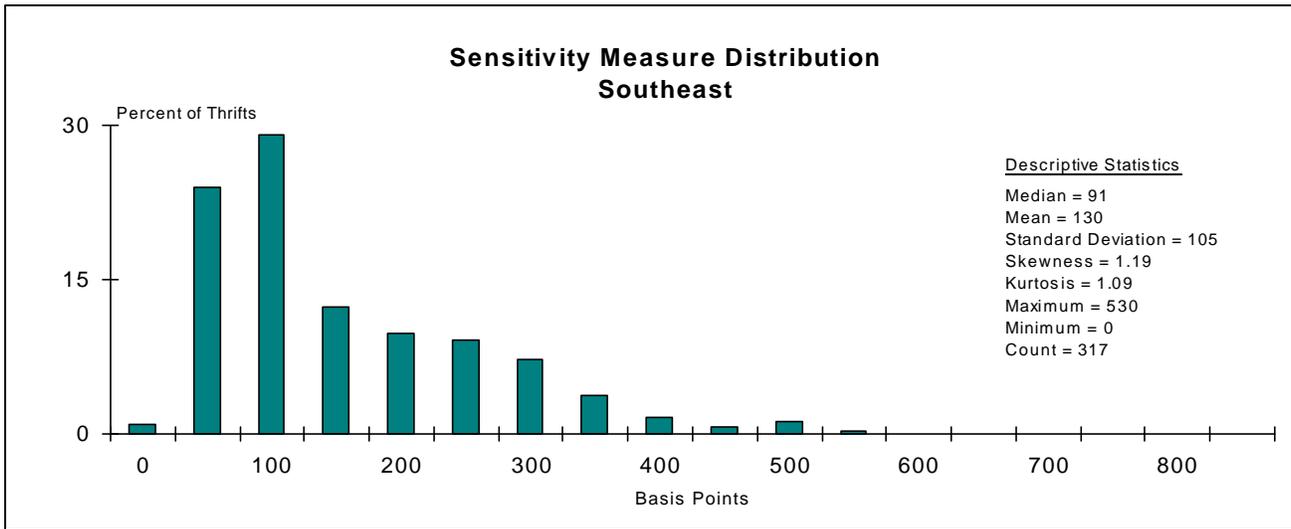
## Appendix A – All Thrifts



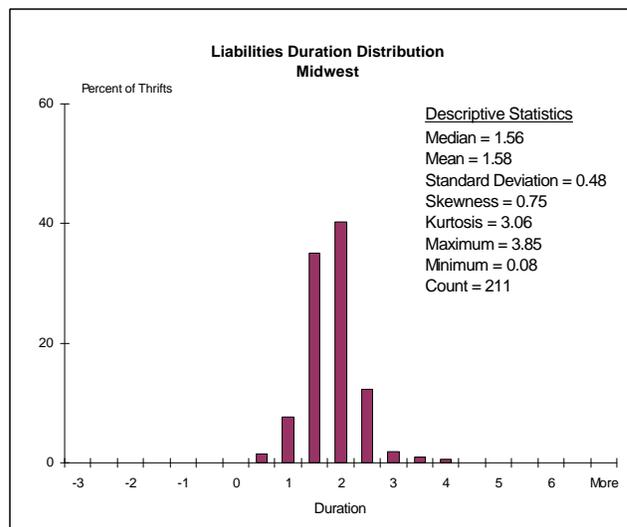
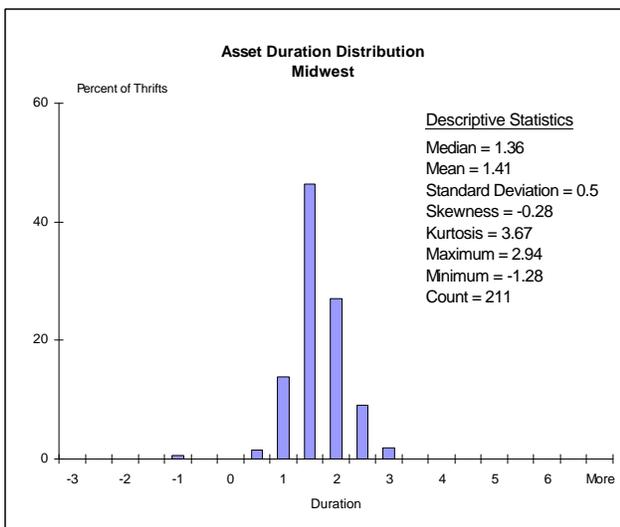
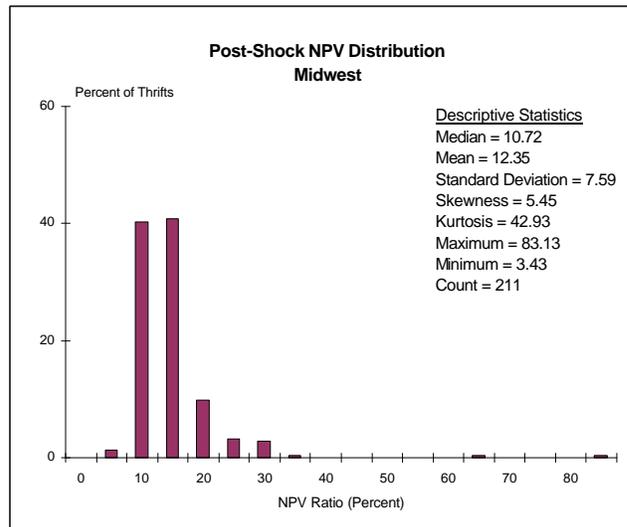
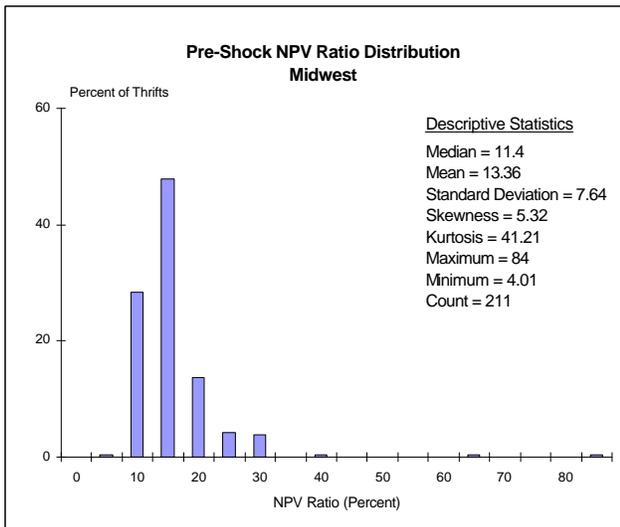
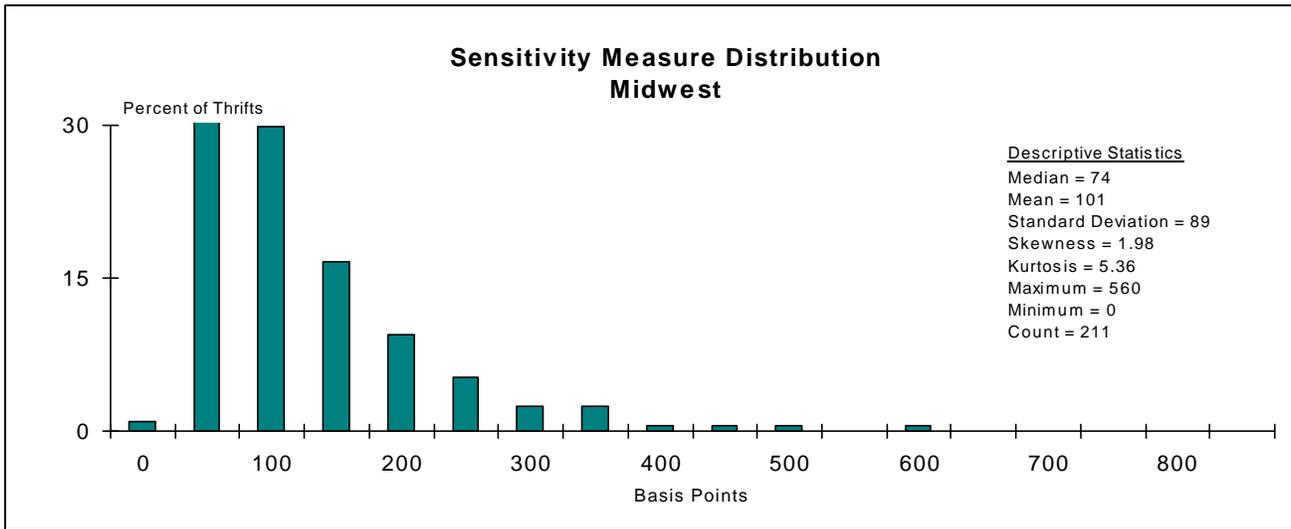
## Appendix B – Northeast Region



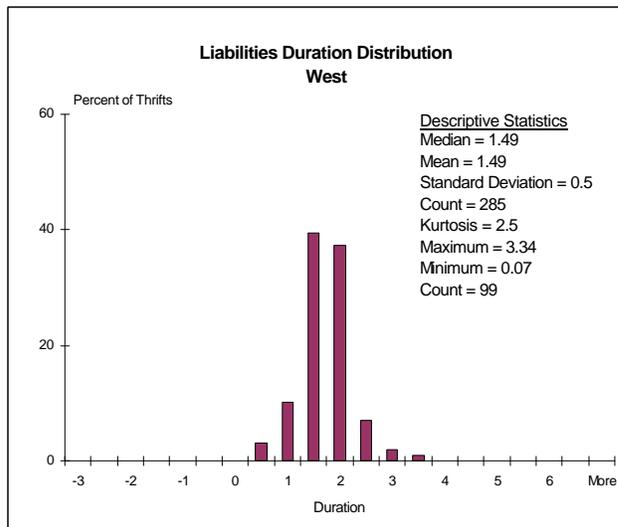
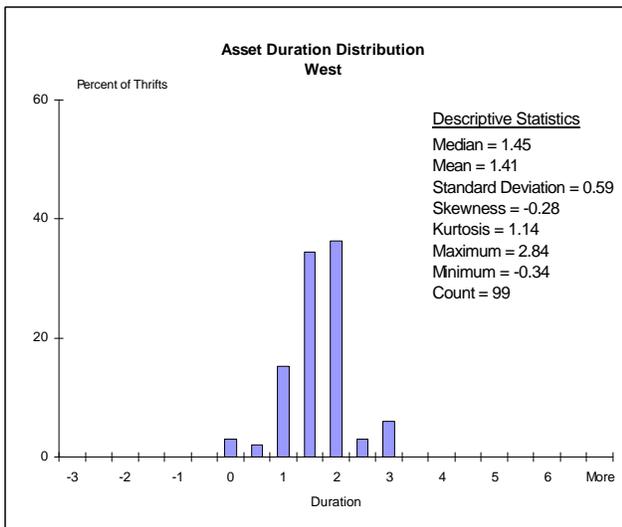
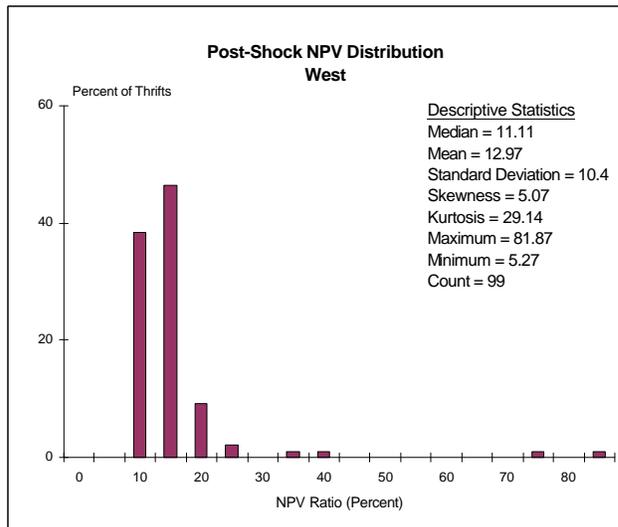
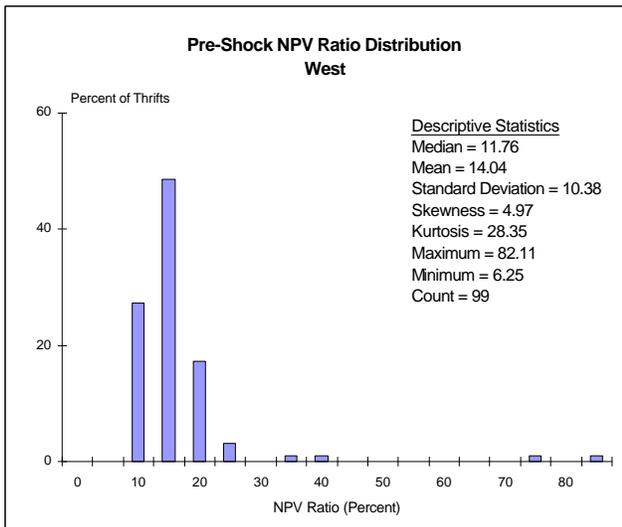
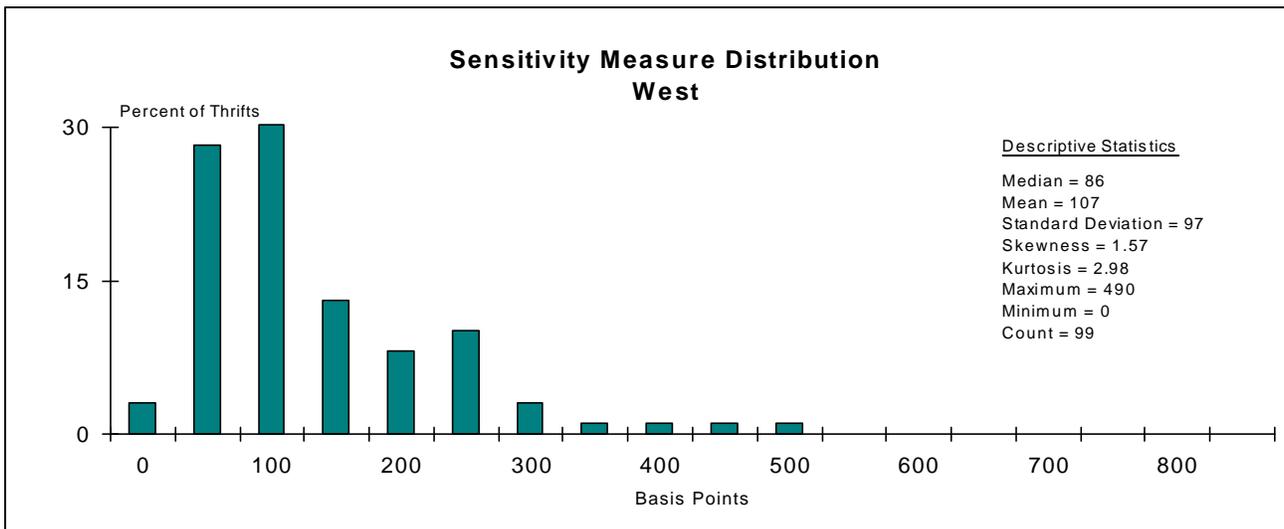
## Appendix C – Southeast Region



## Appendix D – Midwest Region



## Appendix E – West Region



## *Glossary*

**Duration:** A first-order approximation of the price sensitivity of a financial instrument to changes in yield. The higher the duration, the greater the instrument's price sensitivity. For example, an asset with a duration of 1.6 would be predicted to appreciate in value by about 1.6 percent for a 1 percent decline in yield.

**Effective Duration:** The average rate of price change in a financial instrument over a given discrete range from the current market interest rate (usually, +/-100 basis points).

**Estimated Change in NPV:** The percentage change in base case NPV caused by an interest rate shock.

**Kurtosis:** A statistical measure of the tendency of data to be distributed toward the tails, or ends, of the distribution. A normal distribution has a kurtosis statistic of three.

**NPV Model:** Measures how six hypothetical changes in interest rates (three successive 100 basis point increases and three successive 100 basis point decreases, assuming a normal interest rate environment) affect the estimated market value of a thrift's net worth.

**Post-Shock NPV Ratio:** Equity-to-assets ratio, following an adverse 200 basis point interest rate shock (assuming a normal interest rate environment), expressed in present value terms (i.e., post-shock NPV divided by post-shock present value of assets). Also referred to as the exposure ratio.

**Pre-Shock NPV Ratio:** Equity-to-assets expressed in present value terms (i.e., base case NPV divided by base case present value of assets).

**Sensitivity Measure:** The difference between Pre-shock and Post-shock NPV Ratios (expressed in basis points).

**Skewness:** A statistical measure of the degree to which a distribution is more spread out on one side than the other. A distribution that is symmetric will have a skewness statistic of zero.

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