

# The Quarterly Review Of Interest Rate Risk

Office of Examinations, Supervision, and Consumer Protection  
Economic Analysis Division



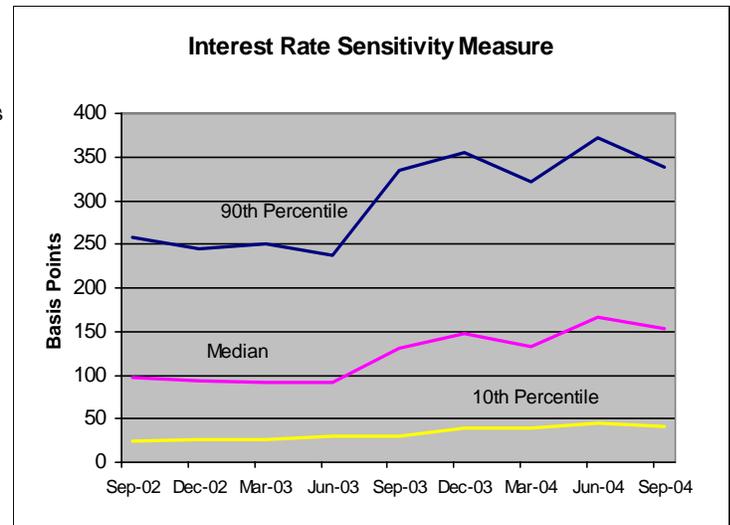
## Special points of interest:

- 30-yr mortgage rate falls
- Medium- and long-term interest rates fall in third quarter
- Third quarter median interest rate sensitivity falls
- Asset duration decreases
- Comparative Regional Analysis
- Feature Article on Stripped Mortgage-Backed Securities and Risk Management

## Interest Rate Sensitivity Falls in Third Quarter

Median interest rate sensitivity fell from 167 basis points in the second quarter to 153 basis points in the third quarter of 2004. The decline in interest rate sensitivity for the thrift industry was due to the decrease in medium- and long-term interest rates in the third quarter.

The median pre-shock Net Portfolio Value (NPV) ratio fell, while the median post-shock NPV ratio rose in the third quarter. The number of thrifts with post-shock NPV ratios below 4 percent remained at three institutions.



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## Stripped Mortgage-Backed Securities and Risk Management

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Derivative mortgage securities were financially engineered to meet growing fixed-income investor demands for mortgage-related products that provide a better estimate of the duration associated with mortgage pass-through securities. With these securities, the total prepayment risk associated with mortgages is redistributed among different classes of bondholders.

Collateralized mortgage obligations (CMOs) and stripped mortgage-backed securities, such as interest-only securities (IOs) and principal-only securities (POs), are attractive, alternative mortgage-related investments for financial institutions. With these secu-

rities, investors are better able to control their prepayment risk exposure.

In the last issue, we discussed the structure of CMOs and showed how they can be used to better manage interest rate risk. This occurs because investors can choose the desired type and amount of prepayment risk.

More specifically, these financial instruments grant investors the ability to more effectively control their exposure to contraction and extension risk. Contraction risk refers to that part of prepayment risk that stems from the decrease in the duration of mortgage pass-through securities and the reinvestment risk associ-

ated with the speedup of prepayments resulting from a decline in interest rates within the negatively convex region of the price-yield curve.

On the other hand, extension risk refers to that part of prepayment risk that derives from the increase in the duration of mortgage pass-through securities and the reinvestment risk associated with a rise in interest rates.

In this issue, we turn our attention to the most popular type of stripped mortgage-backed securities. In particular, we focus on the structure of interest-only and principal-only mortgage pass-through

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## Stripped Mortgage-Backed Securities and Risk Management (continued)

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securities and show how these instruments also can be used to manage interest rate risk.

The mortgage pass-through strip is a unique CMO with only two classes of securities: an interest-only and a principal-only security. These two securities are created by dividing the typical fully amortizing monthly mortgage payment into its interest and principal components and then selling these cash flows separately to investors.

For the most part, IOs and POs are characterized by high yields and returns that are extremely sensitive to changes in interest rates and mortgage prepayment speeds. As a result of their extreme sensitivity to interest rate movements, these derivative mortgage securities have risk-return profiles that make them extremely useful to financial institutions for portfolio hedging purposes.

For example, IOs have attractive “bearish” return features, because greater interest cash flows occur when prepayments of principal fall due to increases in market interest rates. In contrast, POs have attractive “bullish” return features, because the speedup in prepayments when market interest rates fall causes principal to be returned sooner than expected.

Due to the asymmetry in their return profiles to changes in interest rates and prepayment speeds, IO and PO mortgage strips have very different cash flow characteristics.

As a result, their interest rate risk exposures differ sharply.

Indeed, it is the duration and convexity characteristics of their price-yield curves that make interest-only and principal-only mortgage strips particularly attractive for hedging the prepayment risk and interest rate risk associated with mortgage portfolios and mortgage servicing rights, respectively.

### Prepayment Risk and Mortgage-Backed Securities

An inverse relationship exists between the prices of fixed-income financial instruments, such as mortgage-backed securities, and interest rate changes. This inverse relationship is largely determined by what is known as the discount effect. According to the discount effect, the present value of any cash flows received on a security rises as interest rates fall, and vice versa. Interest rate changes also affect the prices of mortgage-backed securities by causing the expected prepayments of principal to either speedup or slowdown. This is known as the prepayment effect.

Prepayment risk is the risk associated with the prepayment effect. It arises because mortgagors have a call option on the mortgage loans that serve as the collateral for mortgage-backed securities. Mortgagors will choose to exercise this option and prepay their mortgages as interest rates fall sufficiently be-

low contract mortgage coupon rates.

The price of a residential mortgage pass-through security is given by the present value of the expected cash flows associated with the pool of underlying mortgages. These cash flows consist of interest payments, scheduled repayments of principal, and any prepayments. It is important to observe that both the direction and size of the change in the price of a mortgage-backed security due to a change in interest rates will be determined by the interaction between the discount effect and the prepayment effect.

For example, when interest rates fall, prepayments rise due to increased mortgage refinancings, and the present value of expected mortgage cash flows also rises as long as the discount effect is larger than the prepayment effect. On the other hand, when interest rates rise, prepayments fall due to decreased mortgage refinancings, and the present value of expected mortgage cash flows also falls as long as the discount effect is larger than the prepayment effect.

We will see below that the interaction between the discount effect and the prepayment effect is particularly important when analyzing the duration and convexity of IO and PO mortgage strip securities.

### Stripped Mortgage-backed Securities

Stripped mortgage-

backed securities are mortgage-related securities that are created from the “stripping” or separation of the interest and principal cash flows associated with the underlying mortgage collateral. The typical mortgage pass-through security involves the distribution of interest and principal payments to investors on a pro-rata basis.

In contrast, stripped mortgage-backed securities involve the unequal distribution of interest and principal cash flows to investors. The process of stripping produces mortgage securities with interest and/or principal cash flows that are dramatically different from those of the underlying pool of mortgages. As a result, fixed-income investors are allowed to take strong portfolio positions on expected changes in prepayment speeds and interest rates.

There are three general types of stripped mortgage-backed securities: synthetic-coupon mortgage pass-through securities, IOs and POs, and CMO strips. Each of these security types uses a different distribution scheme for allocating interest and principal cash flows to investors.

Synthetic-coupon mortgage pass-through securities were first created by Fannie Mae in July 1986. With these securities, any coupon rate can be created with the appropriate proportions of the interest and principal cash flows on the underlying mortgage collateral.

For example, a syn-

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## Stripped Mortgage-Backed Securities and Risk Management (continued)

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thetic 15% coupon rate would be created for a mortgage strip that is allocated 75% interest and 50% principal of the cash flows from an underlying mortgage pool with a 10% coupon rate. This occurs because the 7.50% coupon (calculated as 75% of the 10% underlying coupon) is expressed as 100% of principal; i.e., 7.50% coupon/50% principal = 15.00% coupon/100% principal. This example shows the creation of a premium mortgage strip security because the synthetic coupon rate is greater than the contract coupon rate on the underlying mortgage collateral.

With the appropriate proportions of interest and principal cash flows, it would be straightforward to create a discount mortgage strip security with a synthetic coupon rate below the contract coupon rate on the underlying mortgage collateral. (See Chapter 14, F. Fabozzi, editor, *The Handbook of Mortgage-Backed Securities* for further discussion and additional examples.)

Interest-only and principal-only mortgage strips are extreme examples of the unequal distribution of interest and principal cash flows characteristic of stripped mortgage-backed securities. More specifically, IOs receive only the interest cash flows, while POs receive only the principal cash flows from the underlying mortgage collateral. Fannie Mae created this type of stripped mort-

gage-backed security product in early 1987.

Finally, CMO strips are tranches in a CMO structure. Typically, these strips are divided into two types: those that receive only principal cash flows, and those that receive a large proportion of interest cash flows relative to principal cash flows.

### Interest-Only MBS and Their Price-Yield Curve Characteristics

An IO mortgage-backed security is a special type of CMO bond that receives only the interest cash flows on the underlying mortgage collateral. This type of derivative mortgage security can be issued against either whole mortgage loans or mortgage pass-through securities. Typically, however, they are issued against mortgage pass-through securities.

The price or value of an IO mortgage strip is given by the present value of the expected mortgage interest cash flows to be received. Because there is no face value or principal amount attached to an IO strip, it is customary to express its price as a percentage of the notional principal of the underlying mortgage collateral.

The price of an IO mortgage strip is determined by the amount and timing of the mortgage interest payment stream, which are both uncertain. Changes in both prepayment speeds and market interest rates will affect the mortgage strip's value.

As such, the value of an IO is particularly sen-

sitive to prepayments because the size of the interest cash flow is based on the amount of remaining principal in the underlying mortgage pool. For example, expected interest cash flows for an IO will fall, as prepayments rise, because interest payments are based on a smaller outstanding principal amount, and there are fewer interest payments actually received by investors.

As a result, both the discount effect and the prepayment effect are important determinants of the duration and convexity characteristics of an IO's price-yield curve. In fact, an IO mortgage strip is a rare example of what is known as a "negative duration asset."

As market interest rates fall below the coupon rate on the underlying mortgage pool, the IO mortgage strip's price actually falls. This means that the slope of its price-yield curve is positive over some range of market interest rates. Unlike other fixed-income securities, the price of an IO strip moves in the same direction as interest rates. In addition, the price-yield curve of an IO mortgage strip over this same range of interest rates also displays negative convexity.

The negative duration arises for an IO mortgage strip because the discount effect and prepayment effect move in opposite directions as interest rate fall, and the prepayment effect dominates. For interest rate increases above the coupon rate on the underlying mortgage pool, however, the price-

yield curve of an IO strip looks like that of a typical bond with positive duration and convexity. Over the positively convex region of the IO's price-yield curve, the prepayment effect and discount effect still move in opposite directions, but the discount effect dominates.

From a price performance perspective, the yield actually received by investors on an IO strip will be related to how quickly prepayments are made by mortgagors. While IO strips are attractive investments because of their potentially high yields, they are also very risky due to their extreme sensitivity to prepayments and movements in interest rates.

### Principal-Only MBS and Their Price-Yield Curve Characteristics

A PO mortgage-backed security is a special type of CMO bond that receives only the principal cash flows on the underlying mortgage collateral. This type of derivative mortgage security can be issued against either whole mortgage loans or mortgage pass-through securities. Similar to IO mortgage strips, however, they are typically issued against mortgage pass-through securities.

The price or value of a PO mortgage strip is given by the present value of the expected mortgage principal cash flows to be received. Because the principal amount, or face value, of a PO is always received, the uncertainty is eliminated because POs

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## Stripped Mortgage-Backed Securities and Risk Management (continued)

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are typically issued against AAA-rated MBS. As a result, a PO mortgage strip is issued to investors at a discount to its par value, because it is a zero-coupon bond.

While the total amount of principal to be received is known, the timing of these cash flows is uncertain and will be determined by changes in interest rates and prepayments. For example, an increase in prepayments will produce an unexpected rise in principal repayments. Clearly, the yield actually received by investors on PO mortgage strips will be related to how quickly prepayments are made by mortgagors.

In contrast to IO mortgage strips, the discount effect and prepayment effect move in the same direction for both

interest rate increases and decreases. As a result, the duration of a PO mortgage strip is always positive, and its price-yield displays positive convexity.

However, due to the substantial increase in a PO's price with a decline in interest rates and concomitant acceleration in prepayments, the price-yield curve for a PO is much steeper than that of a non-callable bond. As a result, PO mortgage strips typically have very long durations that are attractive for hedging purposes.

### Portfolio Hedging with IOs and POs

The extreme sensitivity of IOs and POs to prepayments and the asymmetry of their returns to changing interest rates make them attractive as poten-

tial hedging instruments.

For example, IOs can be used by thrift institutions to hedge their fixed-rate mortgage portfolios against interest rate increases. As interest rates increase, the value of mortgages falls, but this decline is offset by the rise in the value of IO strips. This assumes that the increases in interest rates occur over the negatively convex region of the IO's price-yield curve. In addition, thrifts with positive effective duration gaps can combine negative duration IO strips with long duration assets to reduce the duration of their asset portfolio, and thereby reduce the duration gap between assets and liabilities. This would decrease interest rate risk.

On the other hand, POs can be used to hedge an institution's portfolio

of mortgage servicing rights. Mortgage servicing rights behave like IO strips in response to changes in prepayments and interest rates. As interest rates fall, the decrease in the value of mortgage servicing rights is offset by the increase in the value of the PO mortgage strips.

Although IOs and POs are potentially attractive hedging instruments with high yields, they are also very risky due to their extreme sensitivity to changes in prepayments and interest rates. For this reason, care and diligence should be exercised when considering adding these instruments to a portfolio. An institution should fully understand how the addition of these instruments facilitates the management of interest rate risk of the overall portfolio. ■

## Interest Rate Sensitivity Falls in Third Quarter (continued)

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Treasury rates rose for short-term maturities, but fell for medium- and long-term maturities in the third quarter. The rise in short-term rates was due to the three federal funds rate increases made by the Federal Reserve. As a result of these changes in short-, medium-, and long-term interest rates, the Treasury yield curve flattened in the third quarter.

The Freddie Mac contract interest rate on commitments for fixed-rate 30-year mortgages fell to 5.72 percent at the end of the third quarter from

6.21 percent at the end of the previous quarter.

Thrift profitability remained unchanged from the previous quarter. The average return on assets (ROA) for the industry stayed at 1.16 percent.

Due to the flattened Treasury yield curve, the third quarter saw average net interest margin fall to 288 basis points, down from 291 basis points in the second quarter. This slight decrease resulted from lower asset yields and higher liability costs associated with the rise in short-term rates and fall in medium- and long-term rates in the third

quarter.

Total thrift industry earnings rose to \$3.50 billion in the third quarter, from \$3.38 billion in the prior quarter.

In the third quarter, total fee income, which includes mortgage loan servicing fee income and other fee income, rose to 1.22 percent of average assets, up from 1.06 percent in the second quarter.

Other fee income rose to 1.12 percent of average assets in the third quarter, up from 1.08 percent in the prior quarter. This growth has been due to increases in retail bank-

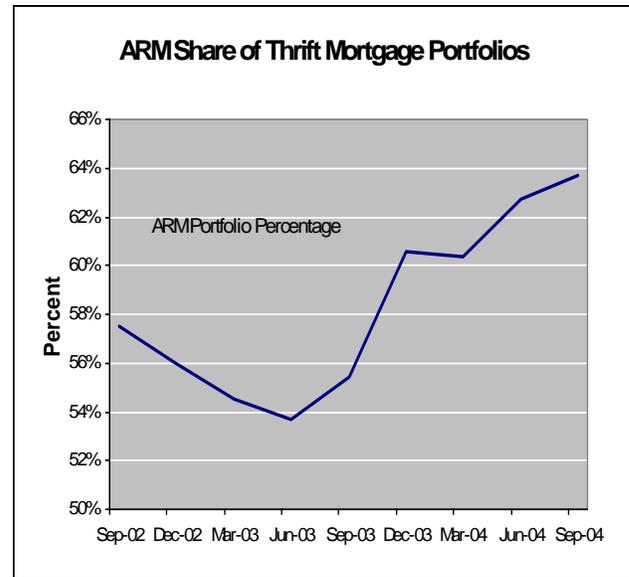
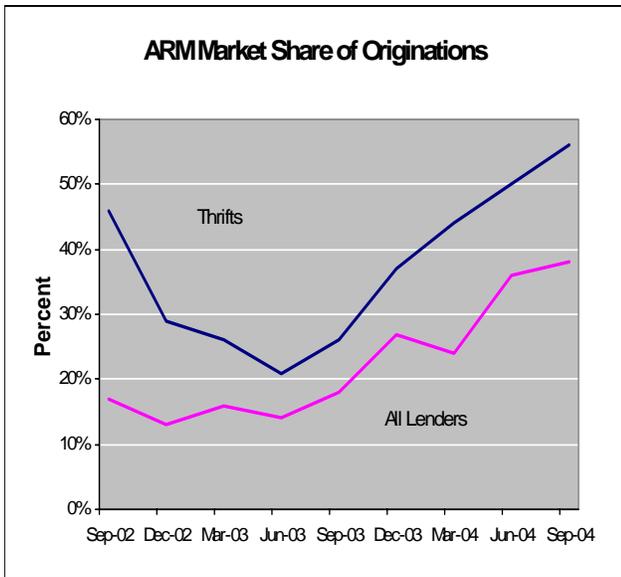
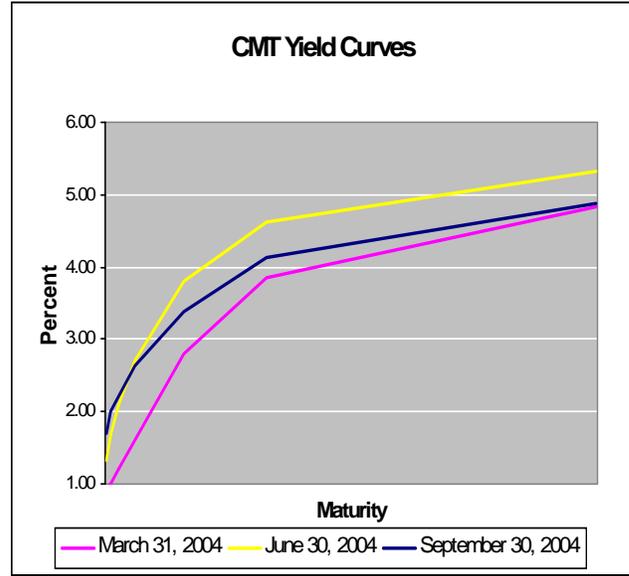
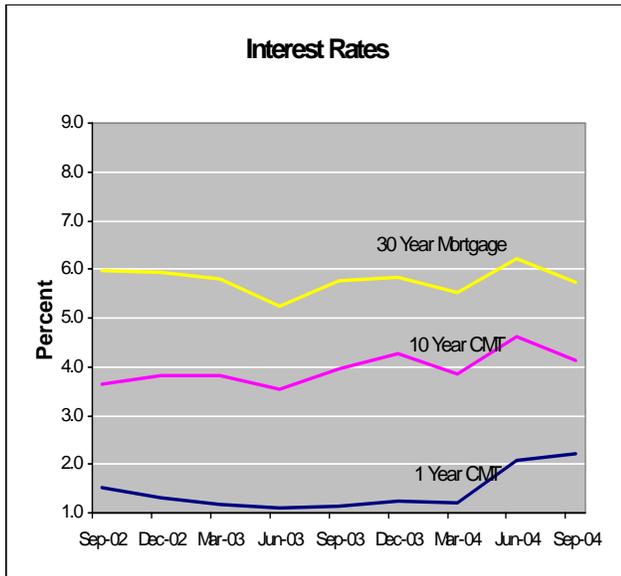
ing fees, growth in trust assets, fees from sales of mutual funds and annuities, and loan servicing income from non-mortgage loans.

Although total fee income rose in the third quarter, its overall increase was hampered by lower mortgage servicing fee income due to impairment charges on mortgage servicing portfolios of several thrifts.

Other non-interest income fell to 0.50 percent of average assets from 0.62 percent between the second and third quarters. Other non-

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## Interest Rates and ARM Market Share



### Interest Rate Sensitivity Falls in Third Quarter (continued)

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 interest income can be extremely volatile because it includes gains and losses on assets sold and also reflects balance sheet restructuring activities.

The third quarter saw the ARM share of total thrift mortgage originations rise to 56 percent, up from 50 percent in the prior quarter.

Consistent with the rise in the share of thrift ARM originations, the ARM share of total 1-4 family mortgages held by thrifts in their portfolios rose slightly to 63.7 percent in the third quarter from 62.7 percent in the prior quarter.

Third-quarter 1-4 family mortgage originations by thrifts fell to \$150.9 bil-

lion, down from \$180.4 billion in the second quarter.

Total mortgage originations in the third quarter were \$172.5 billion, down from \$196.5 billion in the second quarter. Along with the fall in total mortgage loan origination volume, the volume of mortgage refinancing activity also decreased in the third quarter. This was due to the

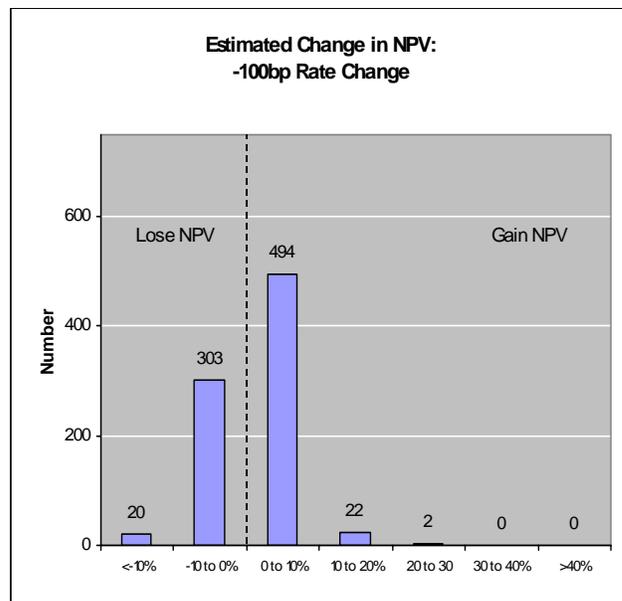
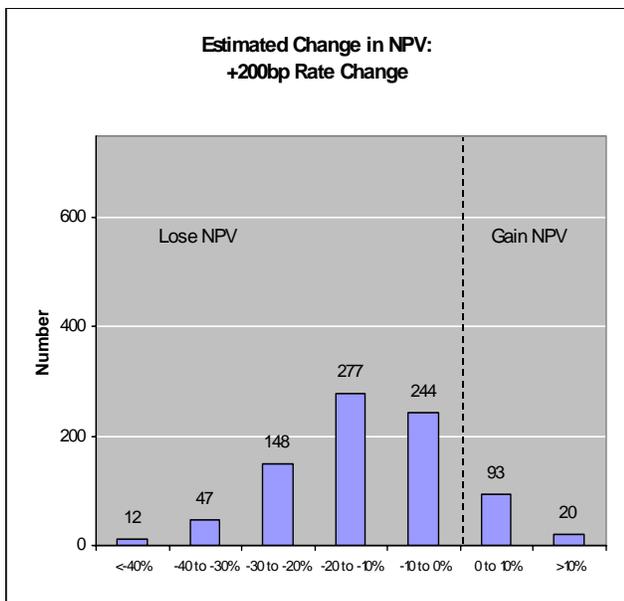
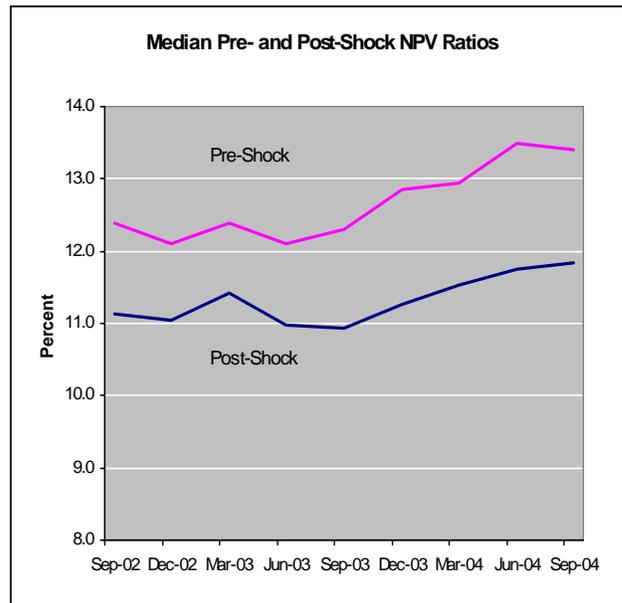
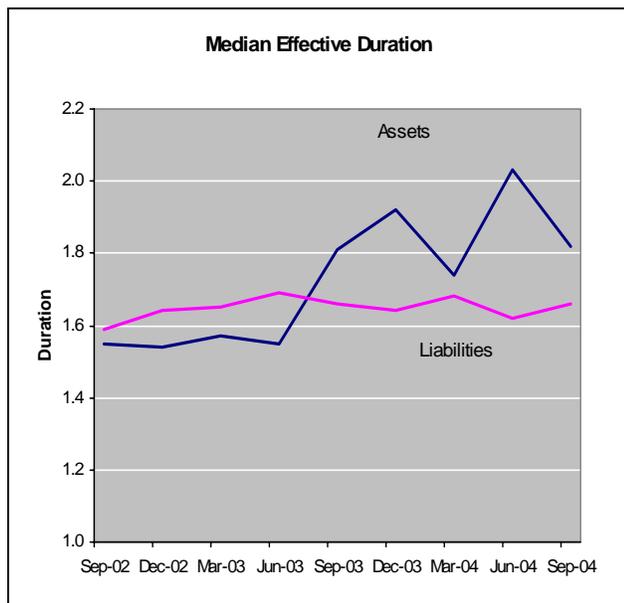
higher long-term interest rates that prevailed during the early part of the third quarter.

Thrifts' share of all 1-4 family originations was 22.3 percent in the third quarter, up from 19.6 percent in the second quarter.

The rate of U.S. home ownership stood at 69.0 percent at the end of the

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### Duration and NPV Sensitivity Measures



### Interest Rate Sensitivity Falls in Third Quarter (continued)

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 third quarter, down slightly from 69.2 percent in the second quarter.

Refinancing accounted for 30.0 percent of thrift originations of single-family mortgages in the third quarter, down sharply from 35.1 percent in the second quarter.

This decrease is consistent with the refinancing

activity of all lenders, where the proportion declined to 33 percent from 49 percent between the second and third quarters.

The industry's effective duration of assets fell from 2.03 to 1.82 between the second and third quarters. With the decrease in longer-term interest rates during the third quarter, the NPV model predicted

an increase in the rate of prepayments of mortgages held in portfolio. This lowered the duration of mortgages and, therefore, total assets duration.

The industry's effective duration of liabilities rose slightly from 1.62 to 1.66 in the third quarter. This was due to the change in interest rates.

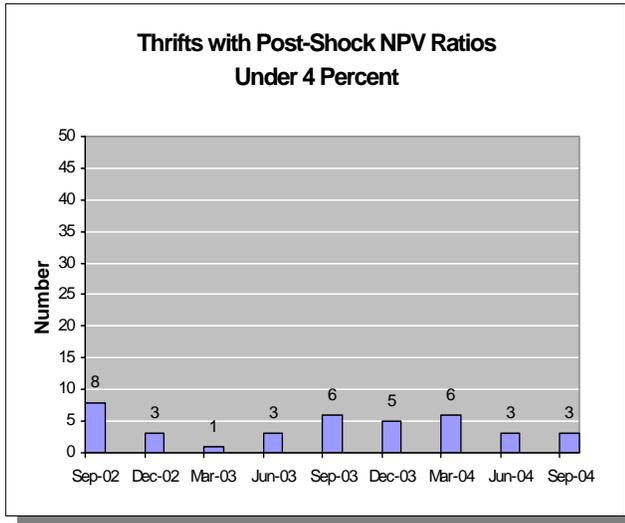
The changes in asset

and liability durations in the third quarter produced a decrease in the positive duration gap for the thrift industry as a whole. This reverses the widening of the positive duration gap for the industry in the prior quarter.

The median pre-shock NPV ratio for the industry fell slightly during the

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## Interest Rate Risk Measures



	NPV as % of PV of Assets		% Change in NPV	
	Jun-04	Sep-04	Jun-04	Sep-04
<b>+300</b>	8.40%	9.29%	-30%	-23%
<b>+200</b>	9.62%	10.35%	-18%	-13%
<b>+100</b>	10.61%	11.13%	-8%	-5%
<b>Base</b>	11.36%	11.60%	0%	0%
<b>-100</b>	11.56%	11.49%	3%	0%
<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>	226	152	174	42	594
<b>6% to 10%</b>	41	64	108	18	231
<b>4% to 6%</b>	4	0	16	5	25
<b>Below 4%</b>	0	0	1	2	3
<b>Total</b>	271	216	299	67	853

	Under 100bp	101-200bp	201-400bp	Over 400bp	Total
<b>Over 10%</b>	246	156	176	27	605
<b>6% to 10%</b>	70	60	79	8	217
<b>4% to 6%</b>	1	0	13	2	16
<b>Below 4%</b>	1	1	0	1	3
<b>Total</b>	318	217	268	38	841

Minimal   Moderate   Significant   High

Minimal   Moderate   Significant   High

### Interest Rate Sensitivity Falls in Third Quarter (continued)

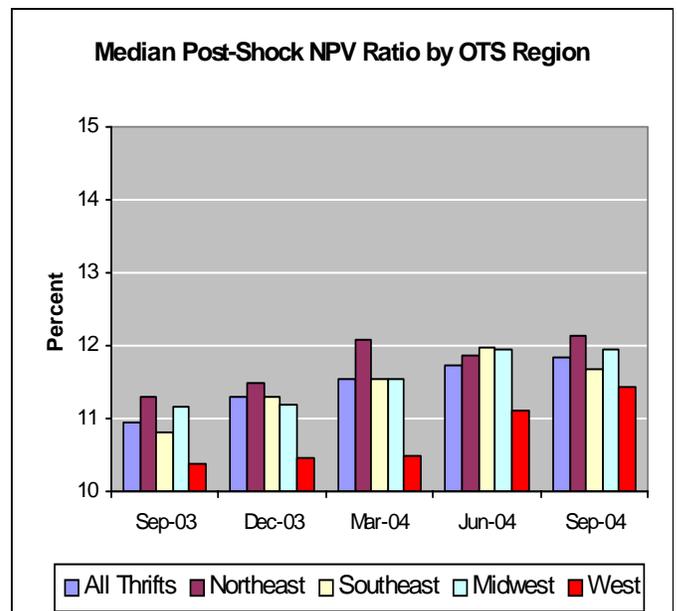
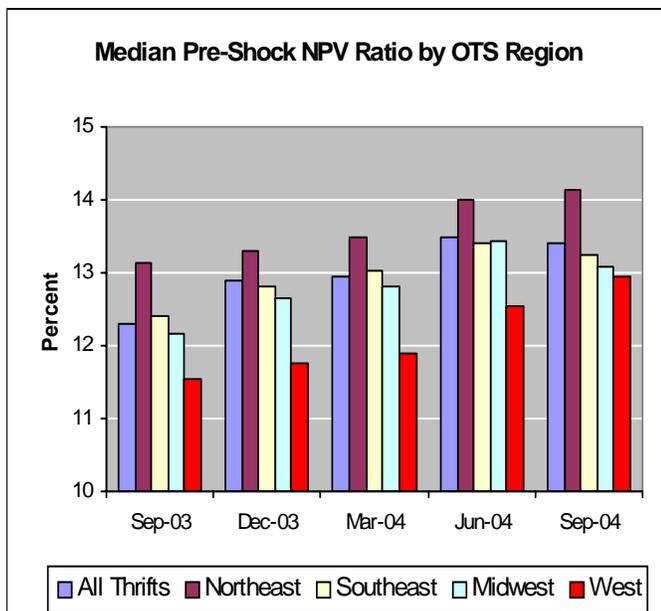
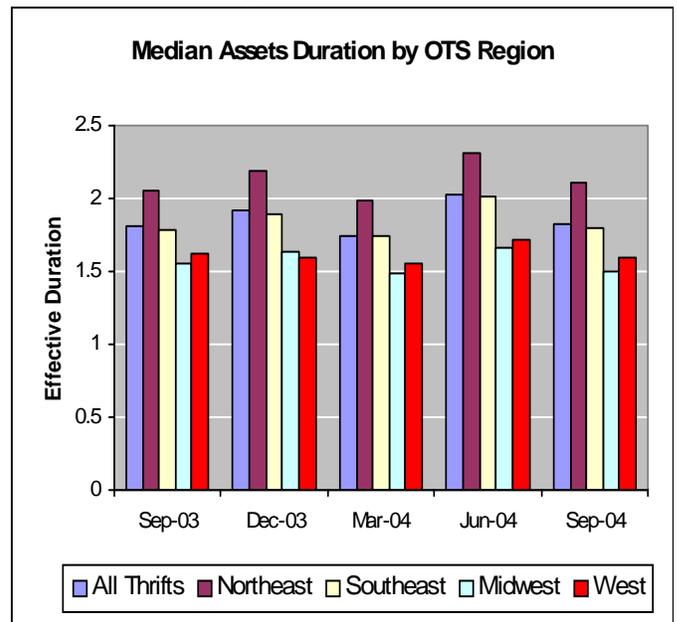
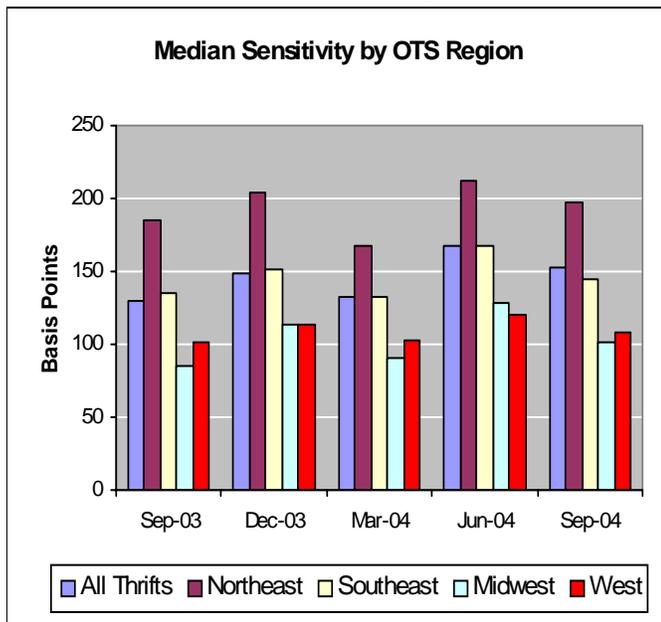
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third quarter from 13.5 percent to 13.4 percent. In contrast to this fall in the median pre-shock NPV ratio, the median post-shock NPV ratio rose, moving from 11.7 percent at the end of the second quarter to 11.8 percent at the end of the third quarter. The number of thrifts

with a post-shock NPV ratio below 4 percent remained unchanged at three institutions between the second and third quarters. The percentage of thrifts with a post-shock NPV ratio over 6 percent rose between the second and third quarters. In the second quarter, these thrifts comprised 96.7 per-

cent of the industry, compared to 97.7 percent in the third quarter. The number of thrifts with a post-shock NPV ratio below 6 percent fell to 19 institutions in the third quarter, down from 28 in the prior quarter. The percentage of thrifts with interest rate sensitivity of 200 basis points or less increased

sharply in the third quarter, rising to 63.6 percent from 57.1 percent in the prior quarter. In addition, the percentage of thrifts with over 400 basis points in interest rate sensitivity fell to 4.5 percent in the third quarter from 7.9 percent in the prior quarter. ■

### Comparative Trends in the Four OTS Regions



#### Regional Comparisons

The Northeast Region had the highest median sensitivity, at 197 basis points at the end of the third quarter, while the Midwest Region had the lowest median sensitivity, at 102 basis points.

All OTS regions experienced a decrease in their interest rate sensitivity in the third quarter. The Midwest Region saw its me-

dian sensitivity fall by 20.9 percent, the largest relative decrease of the four regions. The Northeast, Southeast, and West Regions saw their median sensitivities fall by 7.1 percent, 13.1 percent, and 10.0 percent, respectively.

The Northeast Region had the highest median asset duration, at 2.11 at the end of the third quar-

ter. All OTS regions witnessed a fall in their median asset durations as a result of the decrease in longer-term interest rates between the second and third quarters.

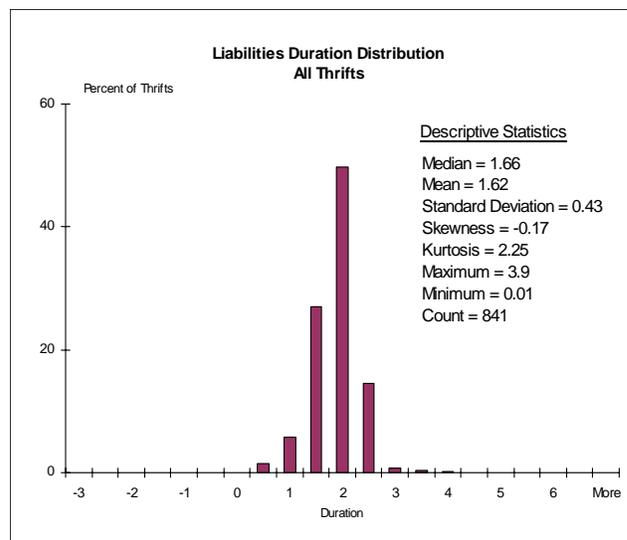
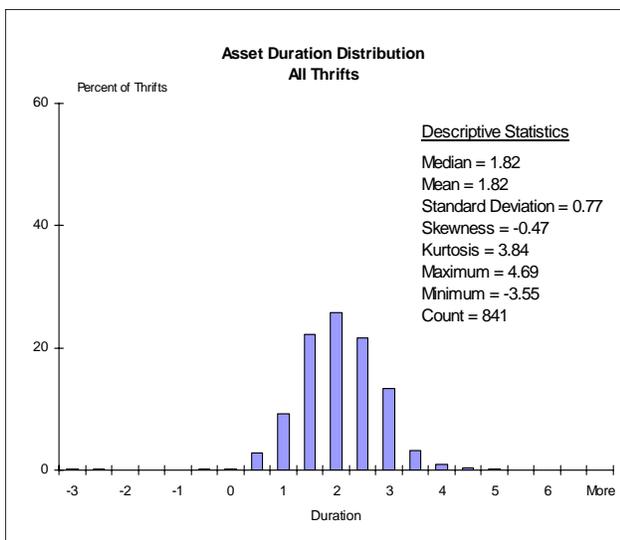
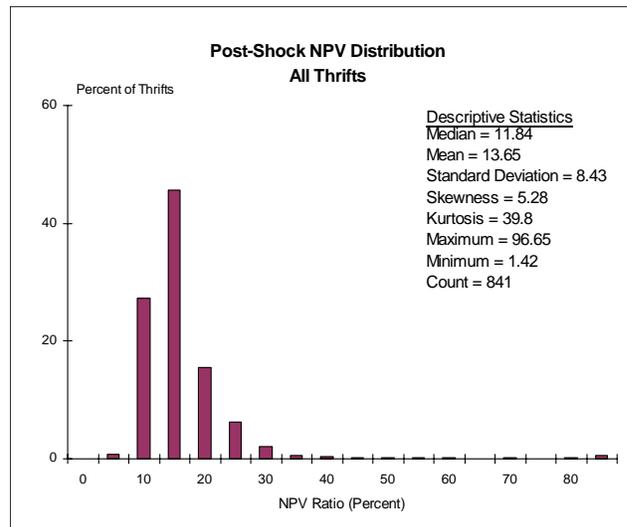
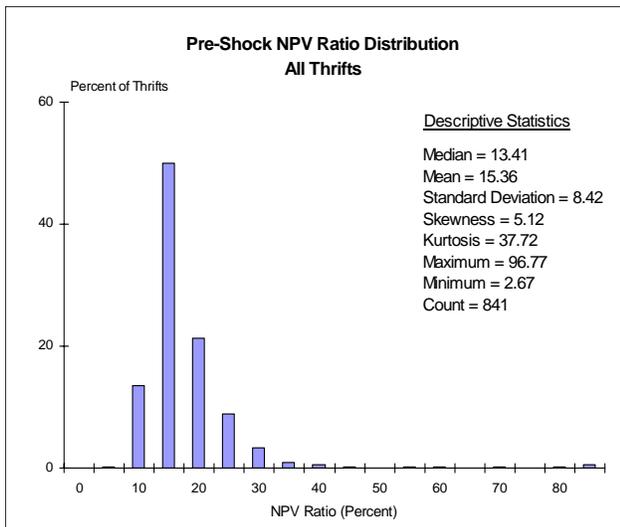
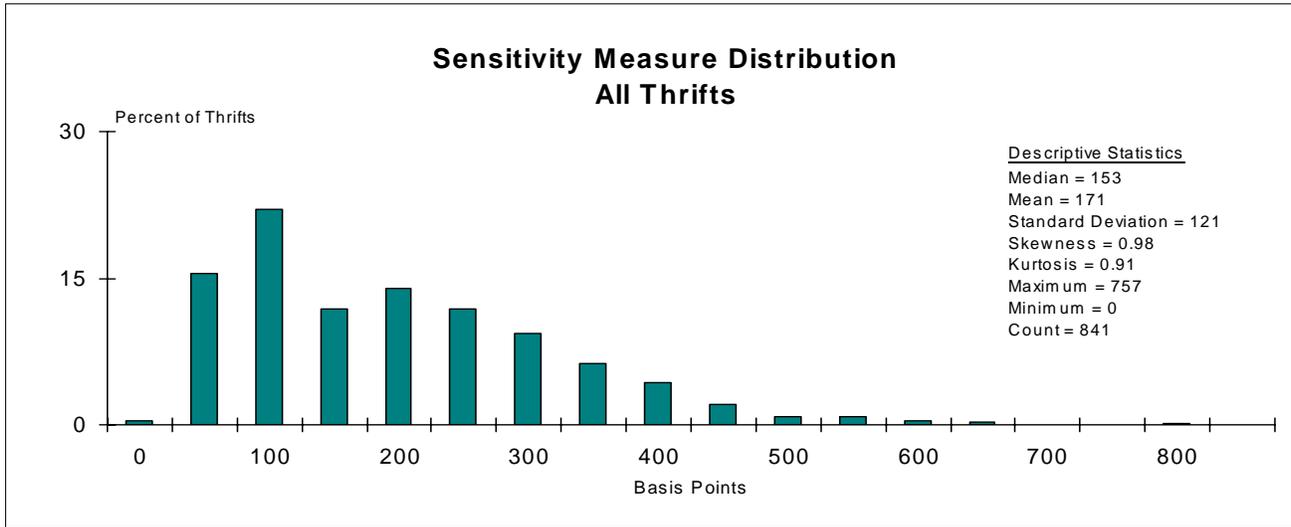
For the third quarter, the Northeast Region had the highest pre-shock NPV ratio at 14.1 percent, while the West Region had the lowest pre-shock NPV ratio

at 12.9 percent.

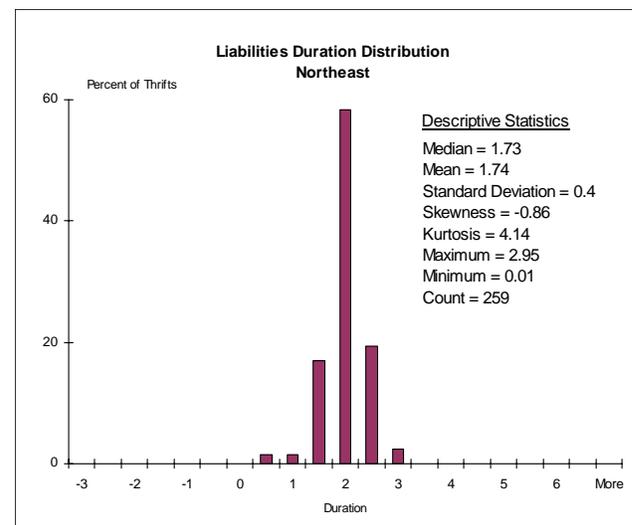
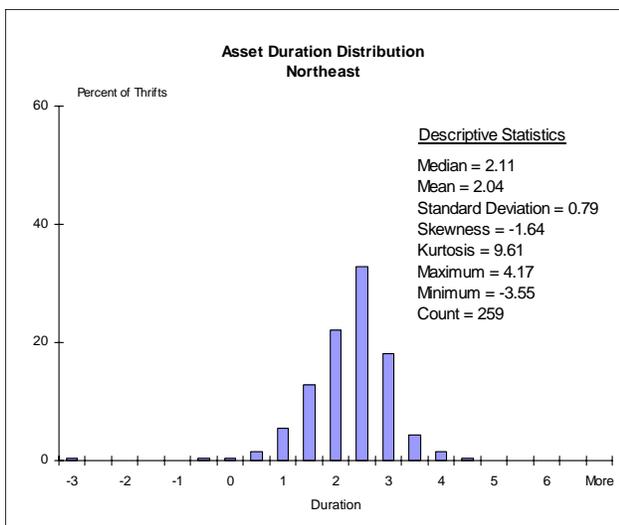
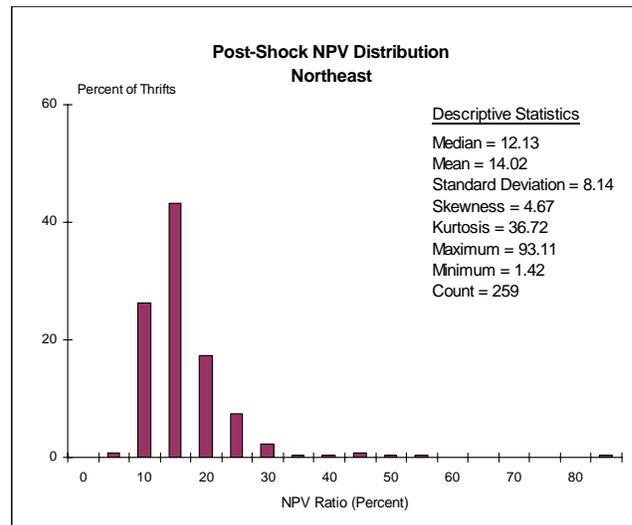
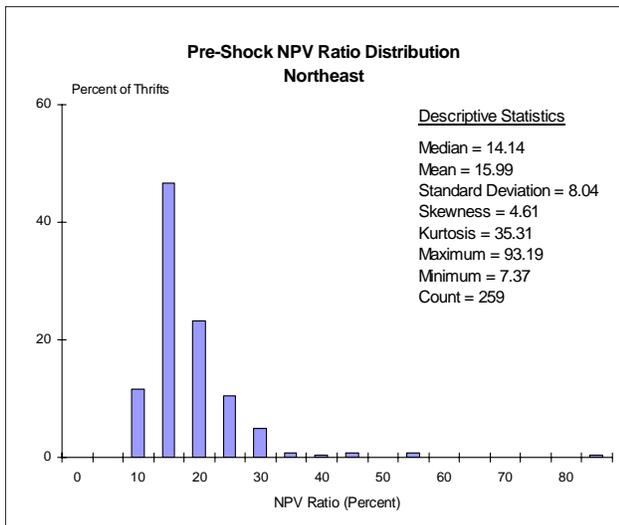
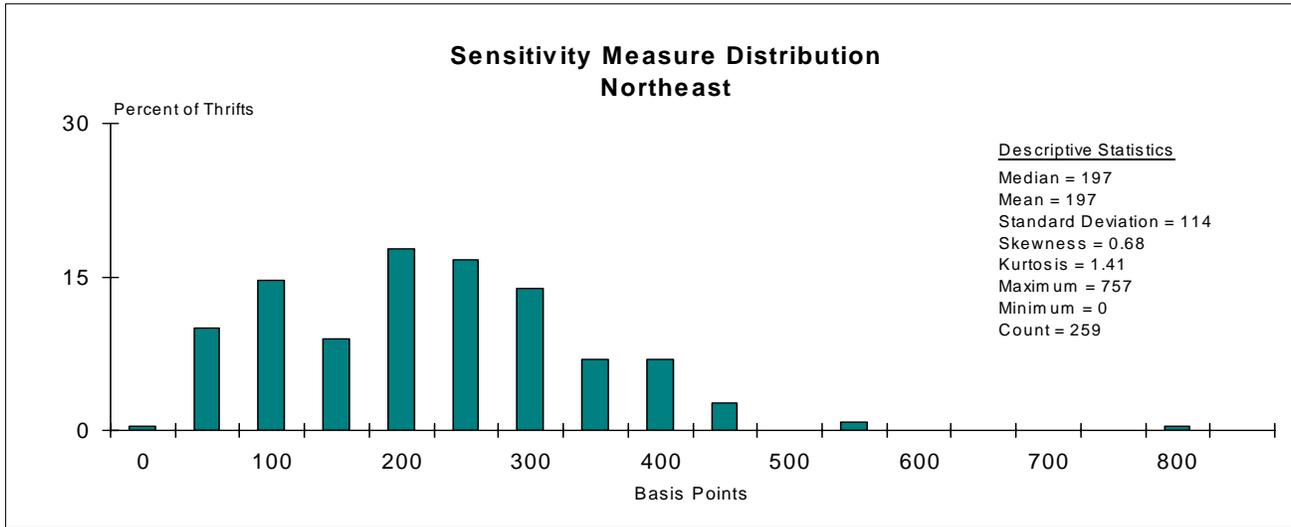
Median post-shock NPV ratios rose for the Northeast, Midwest, and West Regions, but fell for the Southeast Region in the third quarter.

Finally, all OTS regions saw their median liability duration rise as a result of the change in interest rates. ■

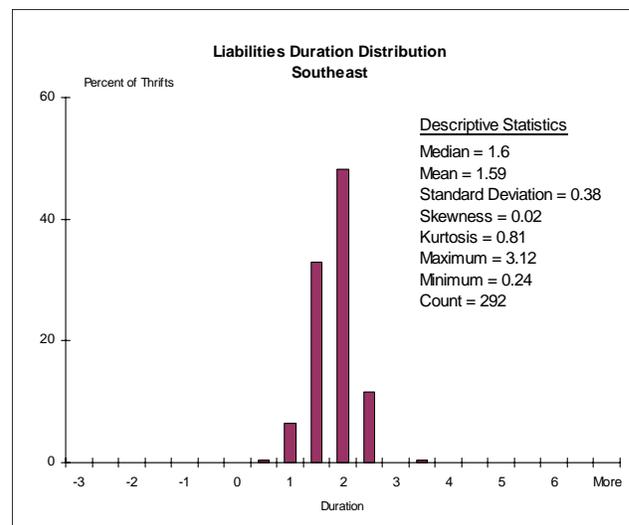
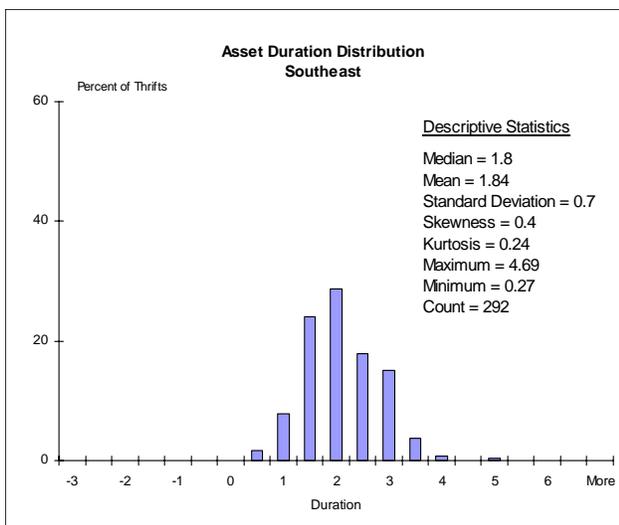
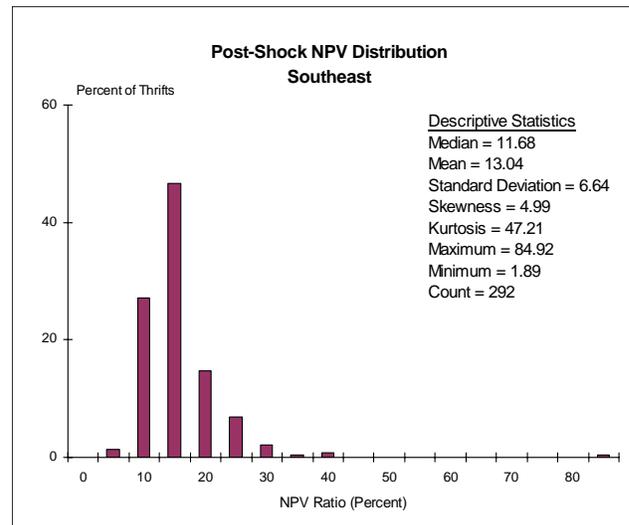
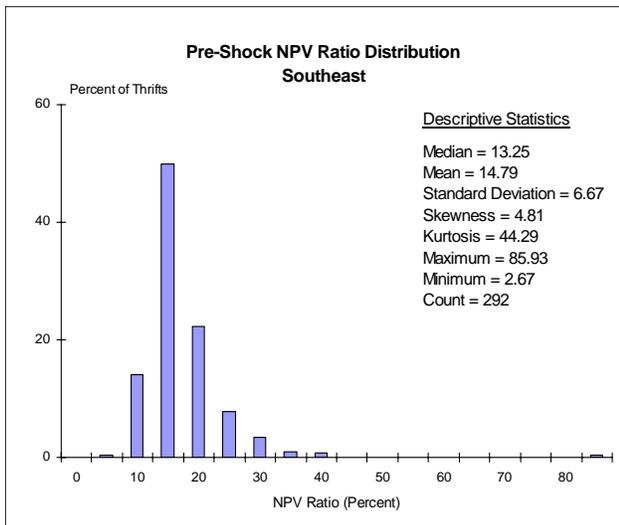
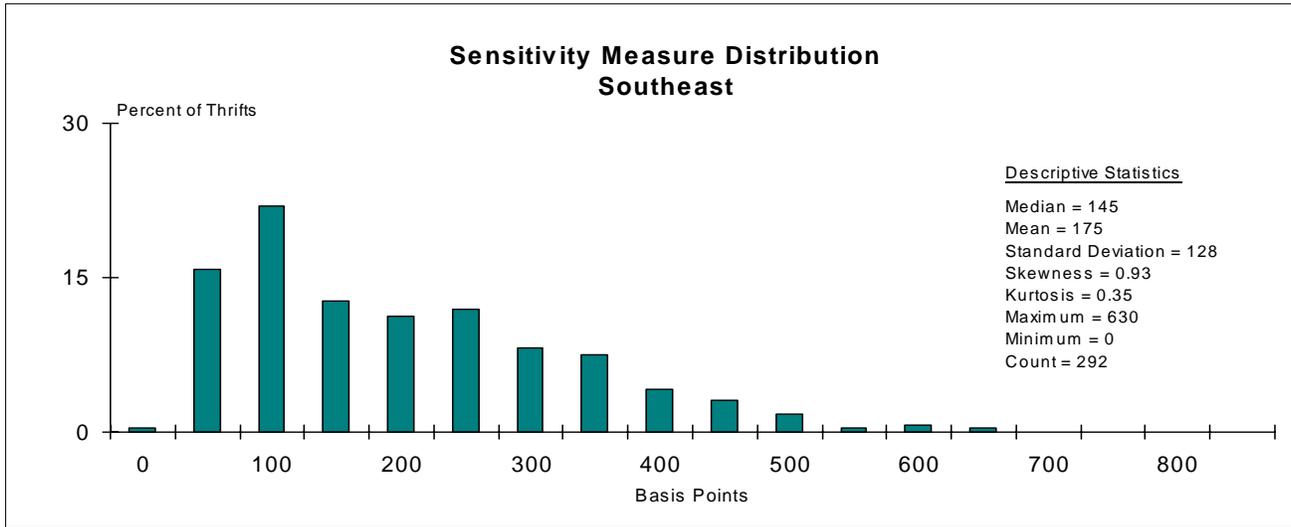
## Appendix A – All Thrifts



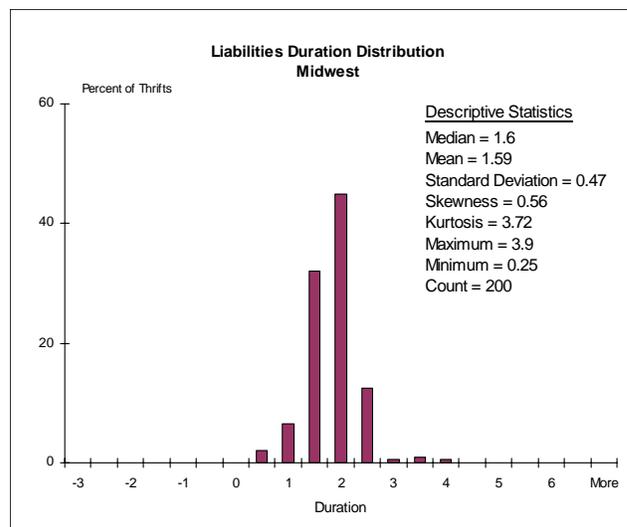
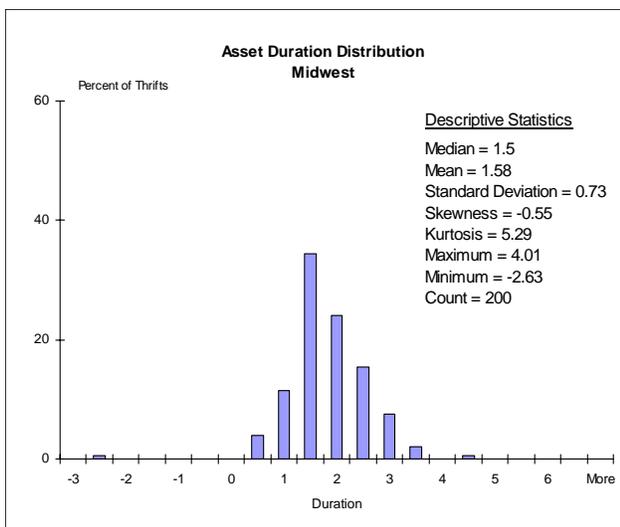
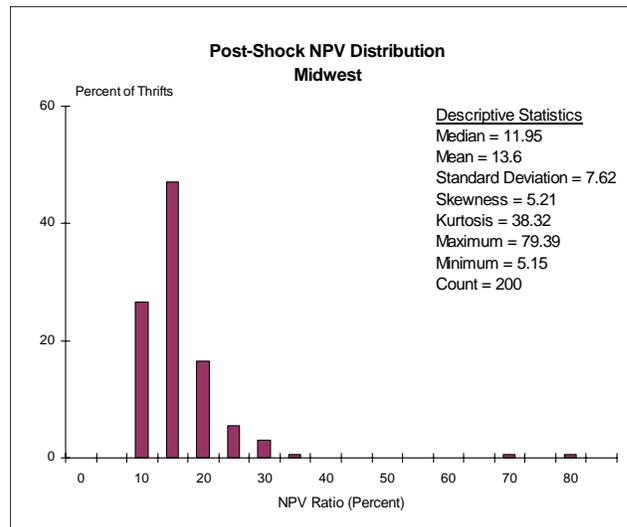
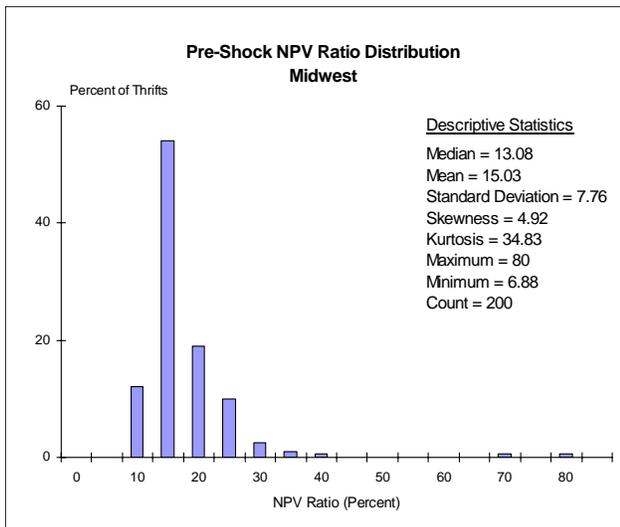
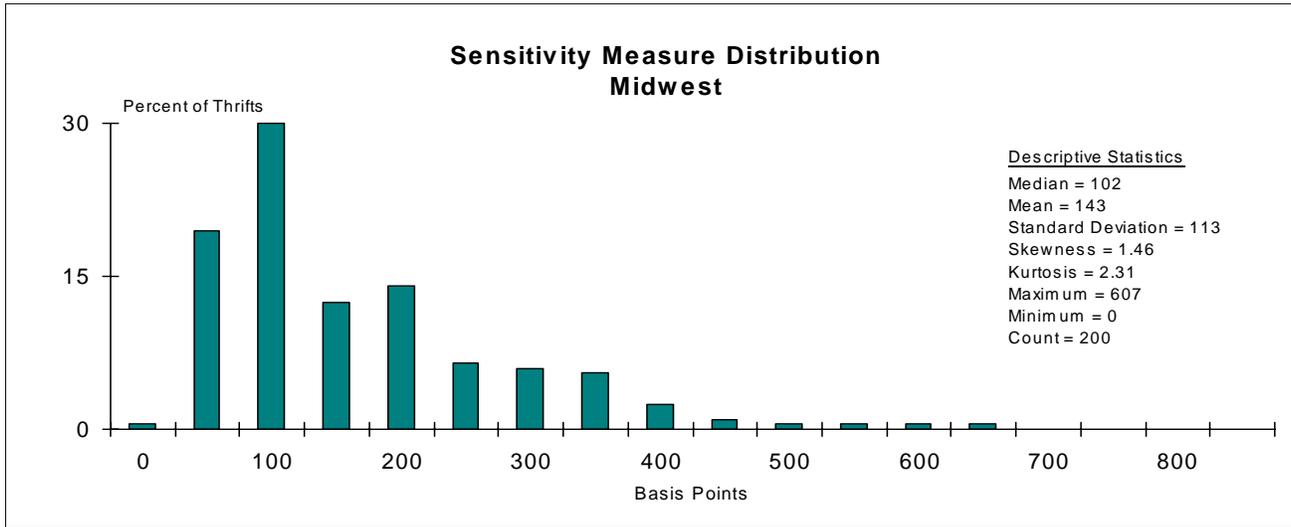
## Appendix B – Northeast Region



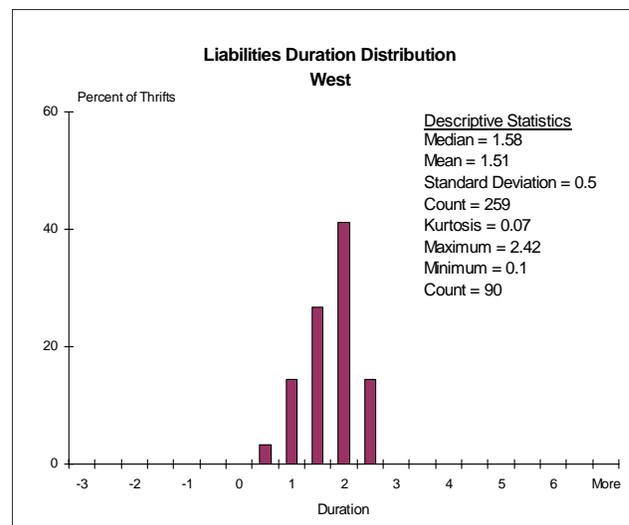
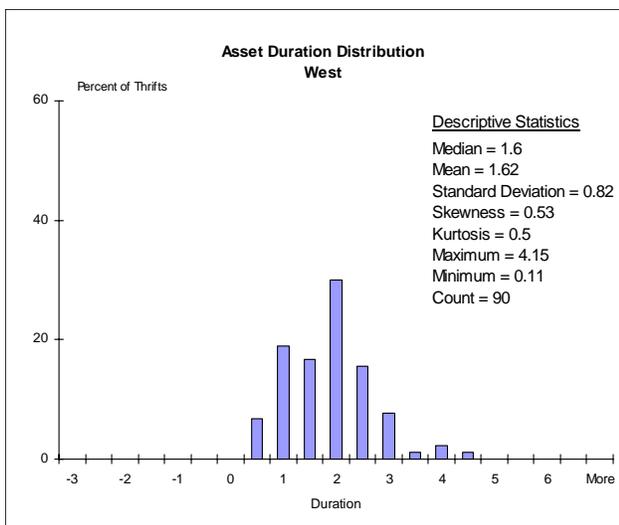
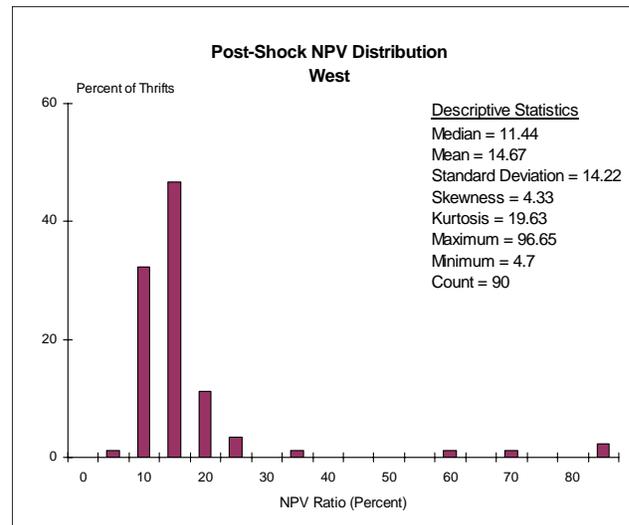
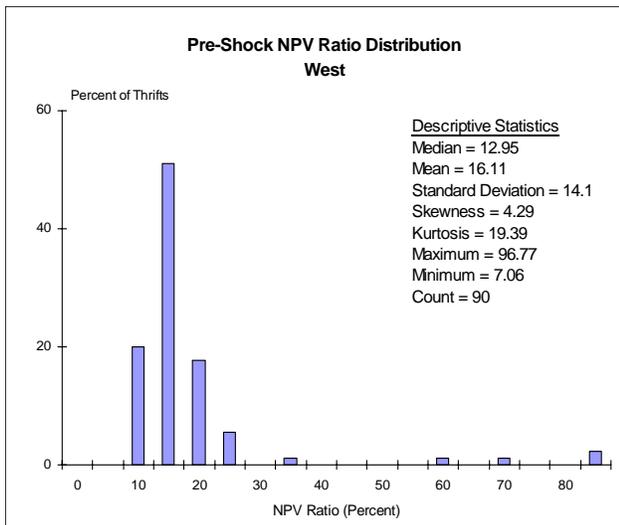
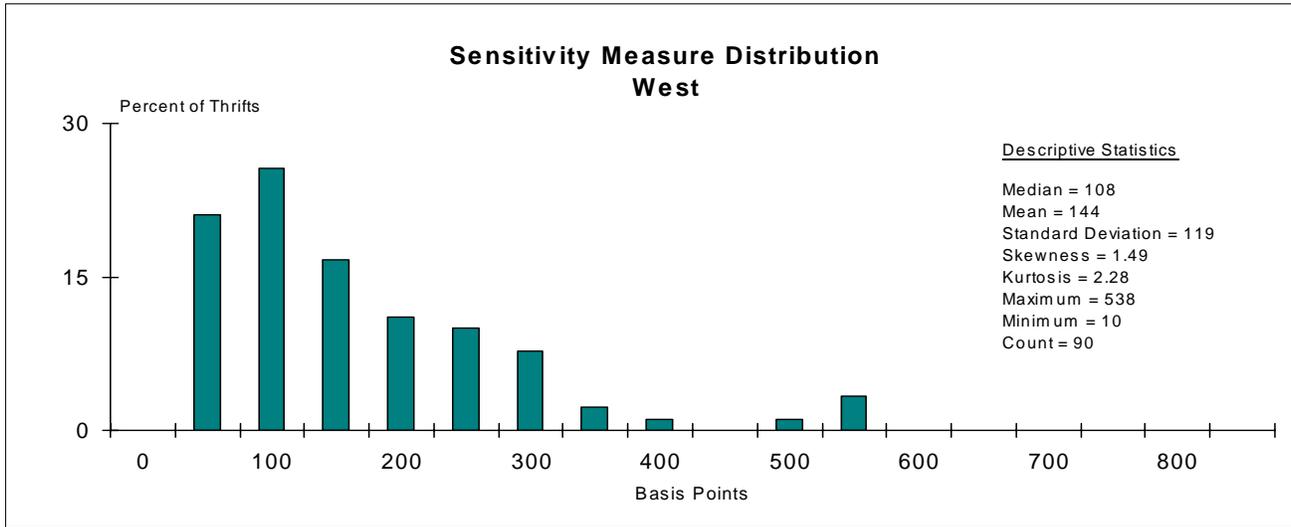
## Appendix C – Southeast Region



## 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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Robert Sutter, IT Specialist, assembled the data reported in the Appendices.

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